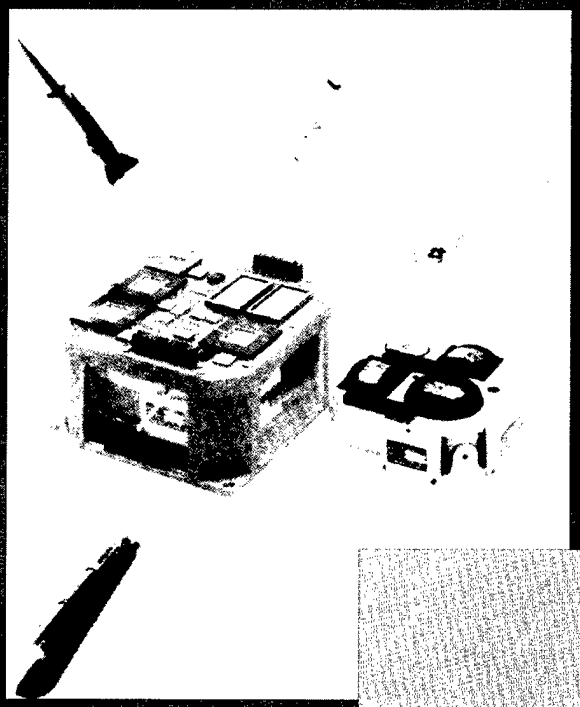
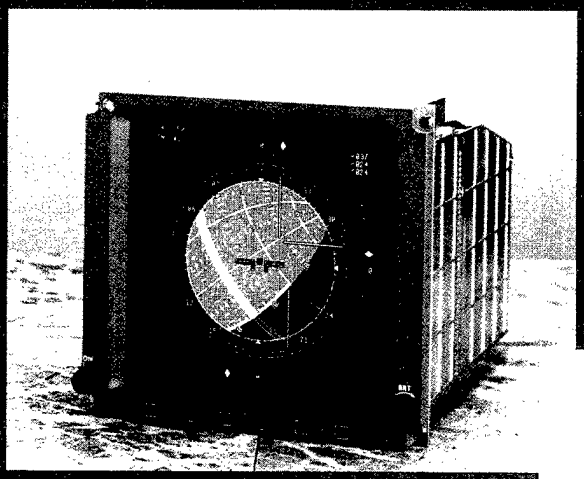
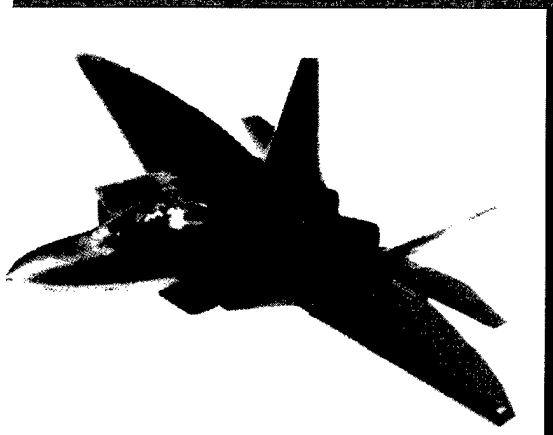
Wright Laboratory

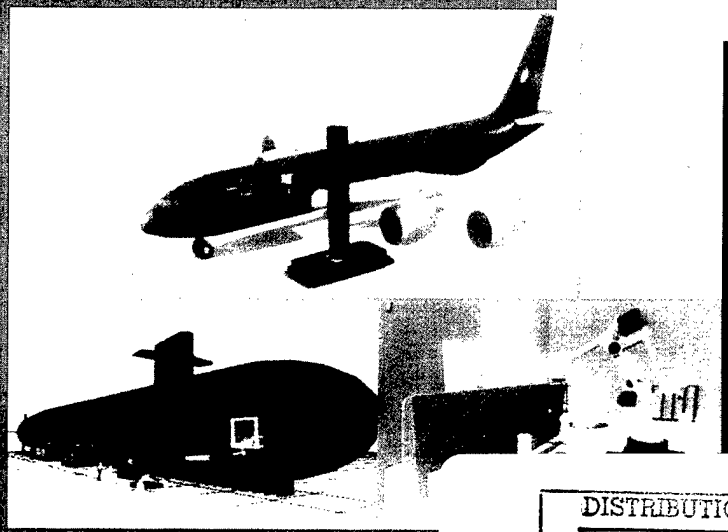
Manufacturing Technology Directorate

A supplement to the MANTECH 1995 Project Book









Project Book Update 1996-97

APPROVED FOR PUBLIC RELEASE

The Manufacturing Technology (MT) Project Book Supplement is designed to inform you of significant accomplishments and to expedite direct exchanges between government and industry management concerned with broadbased MT activities. Recipients are encouraged to route the supplement to associates and other organizational functions engaged in manufacturing related program activities. All comments relating to this supplement should be directed to WL/MTX, Bldg 653, 2977 P Street, Suite 6, Wright Patterson AFB, OH 45433-7739. Telephone: (937) 255-4623. Approved for public release (ASC/PA#96-2582).

FOREIGN DISSEMINATION

Details regarding many specific MT programs are subject to special export controls. Therefore, follow-up from any foreign sources should be processed through embassy channels following normal procedures for request of technical information or technology transfer.

Contents

Introduction

This document is a supplement to The Wright Laboratory Manufacturing Technology Directorate's "Project Book 1995." It is not a replacement, but rather an enhancement to an already vital "living" report with the specific purpose of promoting the transfer of technology. It is organized in such a way as to provide information needed to decide whether the technology described will be useful. For further questions or information, the Technology Transfer Center's telephone number is located below.

In this supplement, **new projects** since the publication of the Project Book in September 1995 and **potential new starts** are summarized on a single page. The summary contains an explanation of the need for the project, the approach taken to accomplish the effort, the benefits expected to be realized, the current status, the name of the project engineer, and performing contractor. For **projects completed** since the printing of the 1995 Project Book, there is a summary of the final benefits of the program, the status of the final technical report or the report number, and the Project Book page number for reference purposes. For **active projects** (those described in the 1995 Project Book which are still active), there is information on the current status of the project and the Project Book page number.

For current information on a variety of directorate activities, visit the **Manufacturing Technology Directorate's homepage** at: http://www.wl.wpafb.af.mil/mtx/mt_home.htm

In all cases, for additional information, submit a request specifying which programs are of interest and what information is needed to:

Technology Transfer Center
WL/MTX, Bldg 653
2977 P. St., Suite 6
Wright-Patterson AFB, OH 45433-7739
(937) 256-0194
fax: (937) 256-1422

Completed Projects

Nationwide Electronics Industry Sector Pilot

(Page 8) Contract Number: F33615-94-C-4431 ALOG Number: 1253
Technical Report Number: In progress

This effort established an electronic network in the electronics manufacturing sector to overcome the barriers of traditional commerce: time, distance, communication, quality, and market access. The effort focused on the network by providing bandwidths that support interactive image-based applications and real-time multi-media applications. All experiments proceeded as planned. This effort was completed in February 1996. **JDL Subpanel**: Advanced Industrial Practices

POC: Wallace Patterson
WL/MTII
(937) 255-8589

Active Projects

Fast and Flexible Communication of Engineering Information in the Aerospace Industry

(Page 3) Contract Number: F33615-94-C-4429 ALOG Number: 1251

Update - This project aimed to develop tools/methods to support increased reliability, speed and flexibility of the Product Development Process for complex highly engineered products. The effort has focused on such methods as using key characteristics during early design as an integrating tool for the proactive management of the supply chain. Benefits from this effort include: improved learning curve and first time capability in manufacturing; faster problem solving, better root-cause analysis, and fewer change orders; reduced cost and improved quality. **JDL Subpanel:** Advanced Industrial Practices

POC: George Orzel
WL/MTII
(937) 255-7371

Fast and Flexible Design and Manufacturing Systems for Automotive Components and Sheet Metal Parts

(Page 4) Contract Number: F33615-94-C-4428 ALOG Number: 1250

Update - This project aimed to develop tools/methods to support increased reliability, speed and flexibility of the Product Development Process for complex highly engineered products. The effort has focused on understanding the strategic implications of make/buy strategies on long term learning manufacturing and design. Benefits from this effort include: improved learning curve and first time capability in manufacturing; faster problem solving, better root-cause analysis, and fewer change orders; reduced cost and improved quality. **JDL Subpanel:** Advanced Industrial Practices

POC: George Orzel
WL/MTII
(937) 255-7371

Active Projects

Textile/Apparel Initiative (Flexible Manufacturing/Information Exchange in a Textile Enterprise)

(Page 11) Contract Number: F33615-94-C-4430 ALOG Number: 1252

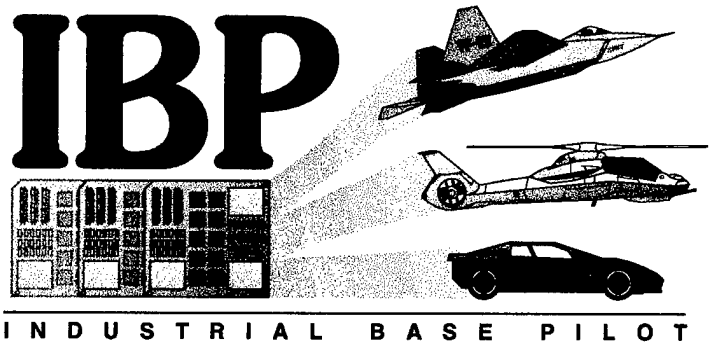
Update - This project extended the basic real-time data collection system (developed and tested in the distributed sewing sections of the apparel enterprise) to collect and use data from other parts of the enterprise; i.e., raw materials receiving through finished goods shipping. This effort will be completed in December 1996. **JDL Subpanel:** Advanced Industrial Practices

POC: Capt Paul Bentley
WL/MTIM
(937) 255-7371

Military Products from Commercial Lines

(Page 14) Contract Number: F33615-93-C-4335 ALOG Number: 1254

Update - Initial test results look favorable. Component Reliability #1 (CR1) is complete; CR2 is nearly complete; and design of experiments (DOEs) are underway. TRW has determined that the pilot modules are commercial items. The Air Force contracting officer has endorsed that determination with Air Force legal concurrence. The pilot contract will be modified accordingly. A transfer agreement has been drafted which states that the pilot modules will be physically transferred to Lockheed after pilot testing. The F-22 SPO will modify their contract for government furnished equipment and Lockheed will decide whether or not to use the modules for engineering manufacturing development. Computer integrated manufacturing integration testing is underway. All parts have been ordered for design validation, scheduled to begin in December. **JDL Subpanel**: Advanced Industrial Practices



POC: Mary Kinsella
WL/MTMC
(937) 255-5669

Military Products Using Best Commercial/Military Practices

(Page 15) Contract Number: F33615-93-C-4334 ALOG Number: 1255

Update - Phase I completed. Process improvements made by implementing 26 business practice initiatives, 14 manufacturing technology initiatives and four process technology initiatives, resulted in a 36 percent reduction in acquisition cost due to processes when compared to the Phase I baseline. Product improvements made primarily by design for manufacturing techniques have resulted in a 17 percent reduction in acquisition cost. An overall 53 percent reduction in acquisition cost is projected. **JDL Subpanel:** Advanced Industrial Practices

POC: Tracy Houpt
WL/MTPN
(937) 255-5669

Active Projects

Agile Infrastructure for Manufacturing Systems Pilot

(Page 47) Cooperative Agreement Number: F33615-95-2-5520 ALOG Number: 1349

Update - Completed first prototype Web pages for AIMS. Draft statement of work developed for second tier subcontractors. Started setting up AIMS laboratory that includes computers, networks, etc. Developed top level program plan for completion of education and migration deliverables. Established task and integration teams for work accomplishment. Developed framework for an information sharing/collaboration plan. Started development of "As-Is" Lockheed launch vehicle model, "To-Be" virtual corporation model, and initial AIMSNet architecture. Started survey of AIMS-related networks. Started Lockheed launch vehicle hardware selection process for demonstrations. Started coordinating AIMS activities with related internal Lockheed programs. Started coordinating with external AIMS related programs. **JDL Subpanel:** Advanced Industrial Practices

POC: Daniel Lewallen
WL/MTIM
(937) 255-7371

Labor Infrastructure for Agile High Performance Transformations

(Page 57) Contract Number: F33615-95-C-5512 ALOG Number: 1366

Update - Case study methodology completed. Case studies for labor organizations are complete. Generic transformation model 99 percent complete. Alpha test of handbooks conducted. Revisions based on feedback are underway. Network case studies and model development continue based on new data. Case studies of best practice companies are being re-drafted. Second drafts of two of the three target companies are complete. Initial case write-up for third target company is complete. Baseline metrics have been identified and collected at two of the target companies. "Train the trainer" sessions have been held at one target company. This effort will be completed in December 1996. **JDL Subpanel:** Advanced Industrial Practices

POC: Capt Paul Bentley
WL/MTIM
(937) 255-7371

Manufacturing Assembly Pilot Project

(Page 59) Cooperative Agreement Number: F33615-95-2-5518 ALOG Number: 1362

Update - The Manufacturing Assembly Pilot (MAP) project has completed the technical portion of the project. Improvements have been implemented in four tiers of an automotive seating supply chain, with companies ranging in size from 15 to 500 employees. As an example of improvements realized, product schedules now flow down to tier four in 11 days, versus 26 days before MAP. **JDL Subpanel:** Advanced Industrial Practices

POC: Cliff Stogdill
WL/MTII
(937) 255-8589

MEREOS - A Product Definition Management System

(Page 60) Contract Number: F33615-95-C-5519 ALOG Number: 1370

Update - All work conducted involved building tools in the Frontier environment to support the prototype development project. This work was divided into three primary activities: development of PACIS I/O facilities in frontier; development of an object model compliant version of the PACIS Table Tool; and development of a dialog management suite for user interfaces. The work to develop an integrated process meta schema was folded into the work on developing the hybrid meta model. Work began on experimental coding of various functions to drive FrameMaker 5 in Frontier. **JDL Subpanel:** Advanced Industrial Practices

POC: Wallace Patterson
WL/MTII
(937) 255-8589

Active Projects

Metrics for Agile Virtual Enterprises

(Page 61) Contract Number: F33615-95-C-5513 ALOG Number: 1365

Update - Conducted all surveys. Have developed map to strategic decisions. Continuing to link to information tools and techniques. Working to implement in existing virtual enterprise. This contract will be completed in January 1997. **JDL Subpanel:** Advanced Industrial Practices

POC: Capt Paul Bentley
WL/MTIM
(937) 255-7371

Qualification Criteria for Agile Enterprises

(Page 66) Cooperative Agreement Number: F33615-95-2-5522 ALOG Number: 1364

Update - This program established a framework and understanding of pre-qualification criteria for rapidly identifying and selecting supply-chain partners. Roundtable meetings to discuss supply chain issues and relationships continue to be held. A supply chain management framework has been developed and implementation of a model in an industrial setting has begun. This contract will be completed in January 1997. **JDL Subpanel:** Advanced Industrial Practices

POC: Capt Paul Bentley
WL/MTIM
(937) 255-7371

The Lean Aircraft Initiative

(Page 1) Cooperative Agreement Number: F33615-93-2-4316 ALOG Number: 1137

Statement of Need

The Lean Aircraft Initiative (LAI) is an Air Force Aeronautical Systems Center (ASC) initiative designed to aggressively pursue and infuse lean principles, concepts, and practices into the defense aircraft industry. Lean production concepts present the US military aircraft industry with an opportunity to address the challenges presented by both reductions in DoD procurements and competition from foreign manufacturers. The adoption of lean practices will allow the industry to meet customer requirements for affordability without sacrificing performance.

Approach

The objective of the Lean Aircraft Initiative is to develop a framework for implementation of a fundamentally different, proven method of manufacturing, enterprise-wide, that would better support the defense aircraft needs over the next 30 years. The Lean Aircraft Initiative is managed through a two-phased consortia arrangement involving industry, government, and the Massachusetts Institute of Technology (MIT). Funding is shared approximately 50/50 between the government participants and the 18 member companies.

Phase I of the LAI concluded in September 1996. It established an Executive Board comprised of senior industry, organized labor, and government personnel to assist in steering the effort (i.e., Air Force lead - ASC/CC). Three Lean Forums were conducted in Phase I to transition research findings to the customer base and establish requirements for both technology and acquisition investment planning processes. Based upon MIT LAI research findings, seven advanced manufacturing demonstration projects which pilot the feasibility of lean practices were funded. Additionally, training in lean principles and practices at both program offices and the ALCs has resulted in the incorporation of innovative acquisition process changes to several key Air Force programs. Industry members are taking LAI findings and applying lean practices within their companies, as evidenced during government/ industry information exchanges.

LAI Phase II modified the current cooperative agreement by extending the period of performance three years and expanding the scope of government and industry participation.

The primary means of documenting LAI research findings will be through the Lean Enterprise Model (LEM). Research results will be organized to populate the LEM with data on lean practices, metrics, benchmarking information, interactions, key benefits, major barriers, and mitigation strategies.

Benefits

LAI is accelerating and focusing the pace of change toward lean in the aircraft industry by providing industry leadership with common understanding of principles, priorities, and data. LAI provides a collaborative environment to define areas of enabling research and development, benchmark, and share experiences and knowledge. Dramatically reduced product cycle times, significant cost reductions, and improved quality are progressively being achieved.

Status

Active
Start date: September 1993
End date: August 1999

Resources

Project Engineer: **John Klempay**
WL/MTAP
(937) 255-3701 Ext 246

Contractor: Massachusetts Institute of Technology

JDL Subpanel: Advanced Industrial Practices

Field Level Repair/Joining of Composite Aircraft Structure

Contract Number: F33615-96-C-5100 ALOG Number: 1421

Statement of Need

Decreasing defense budgets along with increasing commercial requirements necessitates the development of low cost organic matrix composite structures. Affordability includes all steps of the manufacturing process from starting materials to final inspection. A large percentage of the costs are associated with assembly and repair of composite structures. Currently, there are no available joining methods that lend themselves to quick and easy field assembly and repair of aircraft composites. Joining concepts are required that: 1) may be used under field conditions with a minimum of tools/equipment, 2) develop an adequate portion of the strength of the structural members themselves, 3) minimize or eliminate surface preparation, and 4) minimize the need for precise dimensional tolerances. The need exists to have an effective field repair for composite structures. The F-22 System Program Office has expressed high-level interest in this program and a non-disclosure agreement is in progress with Foster-Miller to have Lockheed evaluate the repair process.

Approach

This Small Business Innovation Research (SBIR) Phase I project is developing a unique repair/joining method that eliminates fasteners, does not require autoclave or oven cure, and is equally compatible with field and shop floor operations. The proposed process utilizes ultrasonic energy for two discrete operations: in-situ deposition of a thermoplastic composite laminate patch/splice and insertion of through-thickness pins around the periphery of the patch/splice to react to peel stress concentrations and increase bondline strength.

Status

Completed
Start Date: May 1996
End Date: October 1996

Benefits

If successful, this program would provide a cost effective method of composite field repair while retraining superior performance characteristics. Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from defense and commercial aerospace, to automotive, civil structures, and electrical component industries.

Resources

Project Engineer: **Marvin Gale**
WL/MTX
(937) 255-7362

Contractor: Foster Miller, Inc.

JDL Subpanel: Processing & Fabrication

SBIR Funded

C-17 Lean Aircraft Initiative

Contract Number: F33657-95-D-2026 PTP-0039 ALOG Number: 1506

Statement of Need

Surges in production over the last half century have made the US military aircraft industry a mass production system, but one which overlays what is essentially a craft work force building aero-structures with mostly non-interchangeable parts. Although highly skilled at fitting, few aerospace workers were empowered to improve their processes to solve production problems or to respond to changing conditions. As in Henry Ford's mass production system, aircraft manufacturing processes were owned by remotely located engineers. A number of historical barriers and business practices have impeded the adoption of improved production practices like those pioneered by Japanese auto builders. Cold War emphasis on performance and procurement policies (such as annual buys and pricing based on costs) offered little incentive to improve factory flow or to put the worker back in charge of his work. Risk aversity was a competitive advantage. Investing in lean principles was difficult under these conditions. The Lean Aircraft Initiative has identified flow optimization as an enabling practice for the production enterprise. Benchmarking data from the LAI suggests that a modular organization of the factory is a powerful means of optimizing flow. Derivation and demonstration of the modular factory concept for the defense production environment requires consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to its implementation.

Approach

The modular factory is a reorganization of production resources into semi-autonomous modules, each with total responsibility and authority for a set of processes, adding value to the product to ensure success for the entire enterprise. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gain-sharing incentives for employees. Many enabling approaches are employed in reaching these objectives, including benchmarking, pull-driven scheduling, activity-based methods, process variability reduction, simulation, and labor-management cooperation.

McDonnell Douglas will demonstrate the benefits of lean production in order to incentivize change, and to reduce the cost of the C-17 aircraft. By sharing lean production methods and results through the LAI consortium, change may be incentivized at other aerospace companies, as well as at other MDA facilities.

Status

Active
Start date: October 1995
End date: October 1998

Benefits

The C-17 Lean Aircraft Initiative team has established stretch goals for the project which include:

- 50% reduction in defects per unit
- 50% reduction in inventory
- 50% reduction in assembly cycle time
- 15% reduction in C-17 Cargo Ramp direct labor (fabrication and/or assembly)
- 30% reduction in C-17 Main Landing Gear Pod direct labor

Resources

Project Engineer: **Ed Adkins**
ASC/YCD
(937) 255-9535, ext 4027
Brench Boden
WL/MTII
(937) 255-5674

Contractor: McDonnell Douglas Corporation

JDL Subpanel: Advanced Industrial Practices

Modular Factory for Electronic Warfare Component Manufacturing

Cooperative Agreement Number: F33615-95-2-5564 ALOG Number: 1264

Statement of Need

The Lean Aircraft Initiative has identified flow optimization as an enabling practice for the production enterprise. Benchmarking data from the LAI suggests that a modular organization of the factory is a powerful means of optimizing flow. Derivation and demonstration of the modular factory concept for the defense production environment requires consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to its implementation. This lean implementation effort focuses on demonstration of the modular factory concept against electronic warfare component manufacture, demonstrating emphasis on up-front assessment of cost drivers and affordability concerns.

The Microwave Power Module (MPM) is an enabling technology for the 21st century. MPMs are complete microwave amplifiers of unprecedented miniaturization. Unsurpassed performance in terms of broadband power and efficiency has been demonstrated, but the major challenge prohibiting large scale insertion at this time is cost. Furthermore, defense acquisition focus has changed from performance at any cost to affordability, placing additional pressure on the industrial base. For a defense producer to meet the challenge of reduced cost while attracting a commercial business base, a flexible or modular approach to production is warranted.

Approach

The modular factory is a reorganization of production resources into semi-autonomous modules, each with total responsibility and authority for a set of processes, adding value to the product to ensure success for the entire enterprise. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gainsharing incentives for employees. Many enabling approaches are employed in reaching these objectives, including benchmarking, pull-driven scheduling, activity-based methods, process variability reduction, simulation, and labor-management cooperation.

Northrop Grumman Electronic and Systems Integration Division will develop, through an 18 month pathfinder effort, a streamlined design-to-manufacturing link that includes an automated equipment interface with in-house design tools, a design database, and a networked data link between engineering and manufacturing. These capabilities will be implemented for a pilot demonstration of a modular factory for the production of Microwave Power Modules (MPMs).

Benefits

This project will apply the leading edge production philosophy of modular flow (as identified by the Lean Aircraft Initiative) to the production of MPMs. Expected benefits include 40 percent reduced cost, 40 percent shorter design-to-market cycle time, and higher hardware reliability. Furthermore, an affordable source of MPMs will emerge to support various new and existing systems, upgrades and modifications, and spares requirements. There is long-term potential to open commercial markets for the recipient.

Status

Active
Start Date: October 1995
End Date: October 1998

Resources

Project Engineer: **Brench Boden**
WL/MTII
(937) 255-5674
Walt Spaulding
WL/MTMM
(937) 255-2461

Contractor: Northrop Grumman Electronic and Systems Integration Division

JDL Subpanel: Advanced Industrial Practices

Lead Time Reduction

Cooperative Agreement Number: F33615-96-2-5620 ALOG Number: 1505

Statement of Need

Lead time, one of the greatest contributors to product cost, is driven by many factors, including the supplier base, the flow of products through the factory, and administrative processes. These factors have a direct impact on total span-time and, therefore, directly contribute to aircraft affordability. Application of lean production principles, which are aimed at reducing waste in all functions of the enterprise, would therefore result in greater efficiency and reduced span-times throughout the production realization enterprise, with a commensurate improvement in affordability. The Lean Aircraft Initiative has identified flow optimization as an enabling practice for the production enterprise. Benchmarking data from the LAI suggests that a modular organization of the factory is a powerful means of optimizing flow. Derivation and demonstration of the modular factory concept for the defense production environment requires consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to its implementation.

Approach

The modular factory is a reorganization of production resources into semi-autonomous modules, each with total responsibility and authority for a set of processes, adding value to the product to ensure success for the entire enterprise. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gainsharing incentives for employees. Many enabling approaches are employed in reaching these objectives, including benchmarking, pull-driven scheduling, activity-based methods, process variability reduction, simulation, and labor-management cooperation.

Lockheed Martin will apply the principles of flow optimization to reduce administrative function span-times, supplier lead time, and factory flow for the F-22 program.

Benefits

Estimates for the F-22 indicate that reducing the total production span-time from 32 to 24 months could result in significant cost savings.

Status

Active
Start Date: June 1996
End Date: June 1999

Resources

Project Engineer: **Brench Boden**
WL/MTII
(937) 255-5674

Contractor: Lockheed Martin Aeronautical Systems

JDL Subpanel: Advanced Industrial Practices

Decision Support System for the Management of Agile Manufacturing

Cooperative Agreement Number: F33615-95-2-5525 ALOG Number: 1406

Statement of Need

This effort will focus towards designing a decision support system (DSS) that improves decision making capabilities while fostering supply chain integration. This DSS can be used to integrate data from various sources, formulate problems, generate and evaluate options, and measure decision-making quality. The DSS will be based on quantitative models using data provided by diverse sources of information. The system will enhance the quality of individual and group decisions. It will use interactive technology and client-server architecture. It will be customizable to the needs and capabilities of the user. A demonstration of this technology will be made for both defense and commercial supply chains.

Approach

All Phase I activities were completed on September 21, 1995. These included:

- Completion of the DSS High Level Design Specifications.
- User and functional requirements analysis.
- DSS architecture.
- Individual components of the architecture.
- Performance assessment plan.
- Identification of the defense supply chain for DSS demonstration.

Status

Active
Start date: April 1995
End date: June 1997

Benefits

This program will: reduce cycle time; improve issue effectiveness/fill rate; reduce pipeline inventories; increase the effective usage of resources; and reduce overall supply chain costs.

Resources

Project Engineer: **Wallace Patterson**
WL/MTII
(937) 255-8589

Contractor: Industrial Technology Institute

JDL Subpanel: Advanced Industrial Practices

DARPA Funded

Completed Projects

Manufacturing Technology for Development of Benzocyclobutene/Perflourocyclobutane-Based Color Filter Coatings for Display Applications

(Page 19) Contract Number: F33615-94-C-4407 ALOG Number: 1213
Technical Report Number: In progress.

This program established a low-cost color filter manufacturing method based on improved resin materials. The ink jet printing technique has satisfactorily been developed and has demonstrated great potential. Color filter materials have been narrowed down to three options. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Development of an Extended Long-Life, Long-Arc, Plasma Discharge Lamp for Rapid Thermal Processing

(Page 20) Contract Number: F33615-94-C-4412 ALOG Number: 1223
Technical Report: In progress.

This program established the design for an extended life, long-arc, plasma discharge lamp for cost-reduced active matrix liquid crystal display (AMLCD) manufacturing by improving the suitability of the arc lamp for surface layer treatments of advanced materials. Characterization of the final lamp design has been completed. Work is continuing with a new lamp vendor in an effort to eliminate "single source" dependencies. Use of variable commutation and modulation frequencies in the three arc lamp test stations was investigated. The project was completed in May 1996. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Development of Excimer Laser Crystallization Process and System for Manufacturing High Definition Liquid Crystal Displays

Contract Number: F33615-92-C-5811 ALOG Number: 454
Technical Report: In progress

This program developed an excimer laser-based annealing system to convert amorphous silicon films to polysilicon in order to manufacture thin film transistors (TFTs) and driver circuitry on flat panel active matrix liquid crystal display (AMLCD) substrates. The project was completed in January 1996. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

In-Process Test System for High Definition Flat Panel Displays

(Page 21) Contract Number: F33615-94-C-4425 ALOG Number: 1279
Technical Report: In progress.

This program established the design for an in-process test system capable of meeting the next generation testing demands. The project was completed in February 1996. **JDL Subpanel**: Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Completed Projects

Ferrite Circulators

(Page 24) Contract Number: F33615-93-C-4322 ALOG Number: 1188
Technical Report: WL-TR-96-8014

The ferrite material study has been completed as well as the analytical design study. Improved circulator test fixtures have been designed and implemented. One hundred demonstration parts have been built. The effects of magnet variation are being investigated and the final report has been written. The project was completed in March 1996. **JDL Subpanel:** Electronics

POC: Walt Spaulding
WL/MTMM
(937) 255-2461

Maintenance Free Nickel Cadmium Battery

(Page 25) Contract Number: F33615-93-C-4319 ALOG Number: 446
Technical Report Number: In progress

Update - Variability reduction techniques are being applied to each of four processes critical to the manufacture of maintenance-free NiCd batteries. The processes being attacked are dry and slurry sintering, plaque electro-chemical impregnation, and cell activation. Results to date include increased yields, improved quality, reduced scrap, less rework, and shorter cycle times. Final improvements to the dry sintering process are currently being implemented The project is scheduled for completion in December and a final report will be available in March 1997. **JDL Subpanel:** Electronics

POC: Troy Strouth
WL/MTMM
(937) 255-2461

Continuation of Electronics Industry Environmental Roadmap

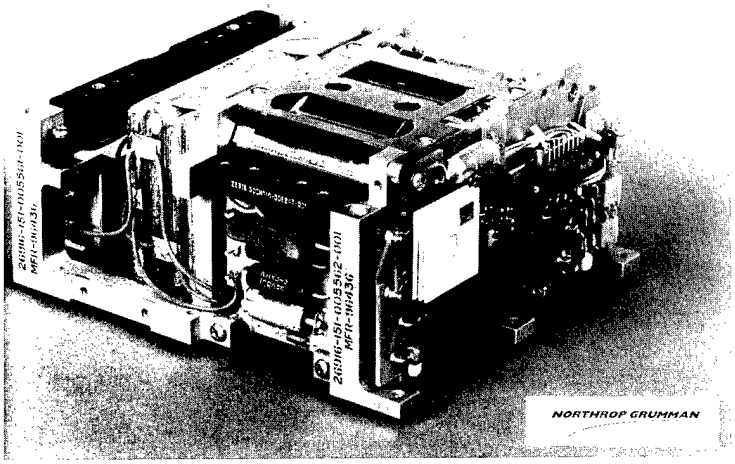
(Page 27) Contract Number: F33615-95-C-5502 ALOG Number: 1329
Technical Report: In progress.

An updated 1996 Roadmap has been developed which addresses key environmental issues for printed wiring boards, their related manufacturing processes, and their assembly. The top issues which need attention in the near term were selected. The project was completed in May 1996. **JDL Subpanel**: Electronics

POC: Richard Remski
WL/MTM
(937) 255-3812

Manufacturing Technology for High Voltage Power Supplies

(Page 36) Contract Number: F33615-89-C-5704 ALOG Number: 72
Technical Report: In progress



This contract was extended to February 1996 and has since been completed. Technical report is in progress. **JDL Subpanel:** Electronics

POC: P. Michael Price
WL/MTMC
(937) 255-2461

Completed Projects

Low Temperature Cleaning of Silicon

Contract Number: F33615-92-C-5989 ALOG Number: 1450
Technical Report Number: WL-TR-96-8030

The overall goal of this effort was to develop low temperature silicon wafer cleaning methods compatible with integrated processing including developing the fundamental science base associated with this process. The contract was completed in August 1996. **JDL Subpanel**: Electronics

POC: Mary Kinsella
WL/MTMC
(937) 255-5669

A Novel Multi-Unit Optical Heterodyne Detection System with Optical and Electronic Common-Mode Rejections

Contract Number: F33615-95-C-5535 ALOG Number: 1356
Technical Report Number: WL-TR-96-8005

During this Phase I Small Business Innovation Research (SBIR) project, the contractor developed a novel optical heterodyne detection approach for semiconductor surface roughness measurement and quality control. In this approach, an acousto-optic Bragg cell was used to provide a suitable optical frequency shift to facilitate the heterodyne detection. Multi-unit heterodyne detections with concentric common-path coherent optical beams are rejections, so that all errors caused by environmental "microphonics" factors (such as vibration and temperature) can be eliminated. In addition, intrinsic feedback signals were introduced into the detection system so that automatic and accurate alignment could be realized. The entire optical heterodyne detection system, featuring very high detectable surface roughness accuracy (to sub Å) and moderate detectable lateral resolution (to sub μm), was able to perform rapid non-contact measurement, and will be readily adaptable to a production environment. The project was completed in November 1995. **JDL Subpanel:** Electronics

POC: Walt Spaulding
WL/MTMM
(937) 255-2461

Instrument for Rapid Quantitative and Nondestructive Wafer Microroughness/Surface Quality Evaluation for In-Process Control

Contract Number: F33615-95-C-5534 ALOG Number: 1357
Technical Report Number: WL TR 96-8004

Technical activity is complete. Final report has been submitted. In this Phase I Small Business Innovation Research (SBIR) project, the feasibility of a new concept to detect and measure sub-micron sized objects on an in-process semiconductor surface was studied. Calculations of the signal-to-noise ratio as a function of various physical parameters showed that the proposed system has adequate S/N to detect 10 nm particles on a wafer surface. Compared to conventional scatterometers, the Sentec unit would have a better S/N than conventional devices when particle sizes are smaller than 100 nm. Analysis also showed that the entire surface of an eight inch wafer could be scanned in five minutes. Computer simulations verified that the signal detected is proportional to the volume density of the contaminants on a wafer. By using several laser lines simultaneously, one can identify the material composition of contaminants on the surface of wafers. The effect of haze could also be reduced. In order to verify the theoretical studies, several breadboard versions of the proposed system were built and tested. Scans across the surface of a standard test wafer showed that the heterodyne method does work. **JDL Subpanel:** Electronics

POC: Walt Spaulding
WL/MTMM
(937) 255-2461

Active Projects

Precision Thick Film Technology for 100 Percent Yield of Large Area High Resolution Color Alternating-Current Plasma Display Panels

(Page 16) Contract Number: F33615-94-C-4406 ALOG Number: 1206

Update - A semi-automated glass substrate or fired dielectric non-contact measuring tool is being developed. Experiments with various weighting set-ups to measure the dielectric thickness are being conducted. Ten-inch screen printed glass plates used for characterization of the process are being developed. **JDL Subpanel**: Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Improved Emissive Coatings for Super High Efficiency Color Alternating-Current Plasma Display Panels

(Page 17) Contract Number: F33615-94-C-4408 ALOG Number: 1207

Update - A tool is being developed to measure the magnesium oxide (MgO) secondary electron coefficient. Measurements were performed on the MgO secondary electron to establish baseline data. Light output of the plasma cell to detect visible and ultraviolet light emitted by the discharge was measured. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Low Cost Electrode Fabrication Process for High Definition System Color Flat Panel Displays

(Page 17) Contract Number: F33615-94-C-4411 ALOG Number: 1208

Update - Silver electrode patterns have been electroplated on five-inch plates overcoated with dielectric glass overlayer. Evaluations of these five-inch plates for electrode deterioration are being made. **JDL Subpanel**: Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Low Cost Flat Panel Display Fabrication

(Page 18) Grant Number: F33615-94-1-4448 ALOG Number: 1280

Update - Work has begun on the first task, printing thin-film transistor layers. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Active Matrix Liquid Crystal Display for Manufacturing Technology

(Page 18) Cooperative Agreement Number: MDA972-93-2-0016 ALOG Number: 1172

Update - The new facilities are completed and the fire damage repaired. The damage to the equipment was more extensive than first believed, causing about a 12-month delay. OIS is now producing products in the new facilities and are in the process of transitioning out of the R&D facilities. It has not been an easy transition for OIS from research into production, but they are coming up the learning curve. The Title III efforts have also increased the demand for the OIS glass. These factors have caused delays in OIS deliveries. They are "spreading the pain" around to all their customers. **JDL Subpanel**: Electronics

POC: Tony Bumbalough
WL/MTMM
(937) 255-2644

Active Projects

Development of an Adaptive Laser Imaging Tool for Large Area Flat Panel Display Mask Generation and Maskless Patterning

(Page 19) Contract Number: F33615-94-C-4441 ALOG Number: 1282

Update - Program effort was put on hold last year due to water damage. Any further work done on Phase I will be funded by Polyscan. Polyscan was acquired by ETEC and the papers filed early 1996. Phase I work is completed. Increased cost share was approved by DARPA. Contract was modified in June 1996 and Phase II funding will be applied so that ETEC-Polyscan can continue the technical effort. **JDL Subpanel: Electronics**

POC: Robert Cross
WL/MTMC
(937) 255-2461

Development of Co-Optimized Rapid Thermal Process and a Silicon Deposition Solid-Phase Crystallization Process for Cost Reduced LCD Manufacturing

(Page 19) Contract Number: F33615-94-C-4449 ALOG Number: 1256

Update - Contract awarded to Aktis (now Intevac Inc., Rapid Thermal Processing Systems). **JDL Subpanel**: Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Development of a Low Cost Environmentally Benign All-Sputtered Fabrication of Thin-Film Transistors for Active Matrix Liquid Crystal Displays

(Page 20) Contract Number: F33615-94-C-4446 ALOG Number: 1281

Update - An investigation of industry needs has been conducted. System requirements have been developed. The DDS-100 R&D multi-station chamber has been installed. Preliminary investigation of silicon nitride for gate dielectric has been completed. **JDL Subpanel**: Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Prototype Development of a Very Large Area, High Performance Microlithography Tool

(Page 21) Contract Number: F33615-92-C-5805 ALOG Number: 445

Update - This program constructed a full-scale prototype of a large-area microlithography tool capable of imaging glass substrates up to 500 mm x 600 mm square at a three-fold increase in imaging throughput rates compared to current technologies. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Active Projects

Development of an Automated Ion Implanter System for Manufacturing High Definition Liquid Crystal Displays

Contract Number: F33615-92-C-5810 ALOG Number: 456

Update - This effort produced one working prototype of a fully automated ion implanter system, a display board and a final report. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Development of a Flat Panel Display Laser Interconnect and Repair System

Contract Number: F33615-93-C-4327 ALOG Number: 1203

Update - Tasks I, II, and III were completed in December 1994. The final report for tasks I-III has been written. Task IV and Task V have been completed. **JDL Subpanel:** Electronics

POC: Robert Cross
WL/MTMC
(937) 255-2461

Integrating People, Products, Processes (formerly, Affordable Multi-Missile Manufacturing)

(Page 22) Contract Number: F33615-95-C-5546 ALOG Number: 1360

Update - Phase I successfully completed. The team developed a common enterprise vision of how a missile manufacturing company will need to operate in the future in order to build missile systems that are affordable and competitive. Each prime contractor has identified key validation exercises that will be accomplished during Phase II. Phase III is planned to start in the third quarter of 1997. There will be a new solicitation released in February 1997 to select those teams that will participate in Phase III.
JDL Subpanel: Electronics

POC: Charles Wagner
WL/MTMM
(937) 255-2461

Alternatives to the Use of Fluoride and Hydrogen Fluoride in Electronics

(Page 26) Contract Number: F33615-95-C-5501 ALOG Number: 1328

Update - Work is continuing on selecting the correct solvent. Acetonitrile and triflouroacetic acid have been demonstrated as possible solvents for use in photoelectrochemical etching. Currently, work involves focusing on the impurities and electrochemistry of trifluoroacetic acid, and continuing to evaluate other acids. **JDL Subpanel**: Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Active Projects

Fluxless, No Clean, Solder Processing of Components Printed Wiring Board

(Page 27) Cooperative Agreement Number: F33615-95-2-5511 ALOG Number: 1330

Update - The primary milestone related to the hardware portion of the system build decision has been met. Major new applications have been demonstrated with the process. **JDL Subpanel:** Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Jet Vapor Deposition: A New Environmentally Sound Manufacturing Process

(Page 28) Contract Number: F33615-95-C-5510 ALOG Number: 1332

Update - Program has been re-directed to investigate the use of a powdered metal deposition source in response to deficiencies discovered with the wire feed source. The pilot JVD system will be modified for the new source. **JDL Subpanel**: Electronics

POC: Walt Spaulding
WL/MTMM
(937) 255-2461

Green Card: A BioPolymer Based and Environmentally Safe Printed Wiring Board Technology

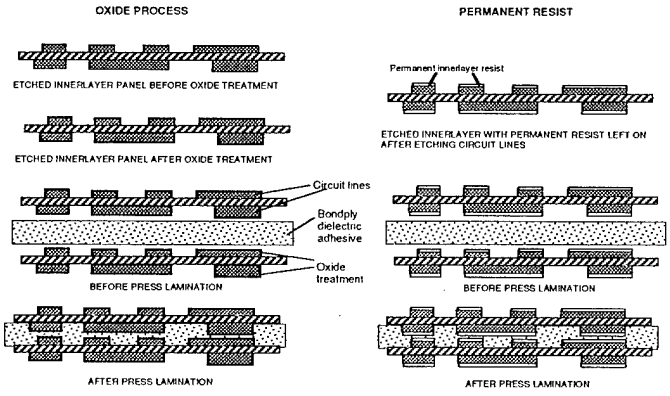
(Page 28) Contract Number: F33615-95-C-5509 ALOG Number: 1335

Update - A four-layer printed wiring board has been selected as a test vehicle, as per the initial schedule. This board is an actual example of a customer build request. All the required wiring, hole location details and other data needed to accomplish the build is readily available. The materials listed above will be used to develop an alternative PWB or "Green Card" that is by design easier to reclaim and recycle, and reduces current waste streams. **JDL Subpanel**: Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Permanent Dry Film Resist for Printed Wiring Board Process Simplification and Environmental Benefit

(Page 29) Contract Number: F33615-95-C-5504 ALOG Number: 1343



Update - Task I, Specifications and Test Vehicle Selection has been completed. Task II, Understanding the Technology, is in progress. Resist candidates are being evaluated based on process restrictions, and physical, electrical, chemical and mechanical requirements. **JDL Subpanel:** Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Active Projects

Tertiary Recycling of Electronic Materials

(Page 30) Contract Number: F33615-95-C-5507 ALOG Number: 1345

Update - A second generation demonstration recycling reactor has been fabricated. The reactor incorporates improvements on the original design. Initial experimental runs on the new reactor are complete and the data is being analyzed. The next steps will include some minor modifications to the system and the optimization of processing conditions such as flow rate. In support of the effort, New Mexico Engineering Research Institute (NMERI) conducted a survey to determine the quantities, types, material composition, and locations of electronic scrap in the United States. NMERI is now in the process of developing a detailed database and model for an economic feasibility analysis. They are also conducting toxicity assessments of the products produced by the reactor. A final process demonstration is scheduled for December 1996. **JDL Subpanel:** Electronics

POC: Troy Strouth
WL/MTMM
(937) 255-2461

Revolutionary Environmental Manufacture of Printed Wiring Boards with Electroless Plating and Conductive Inks

(Page 31) Contract Number: F33615-95-C-5505 ALOG Number: 1344

Update - The photocatalyst development work is complete. The screen printing application process is defined and a process data sheet has been prepared. The experimental matrix to evaluate Ormet ink process variables continues. Test boards have been constructed and thermal shock testing has begun. **JDL Subpanel:** Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Zero Dump Electroplating Process Development

(Page 31) Contract Number: F33615-95-C-5506 ALOG Number: 1342

Update - A new experimental matrix was formulated in order to electroplate at higher current densities. The formulation is for periodic current wave forms and not periodic reverse current wave forms, which will be investigated at a later date. Progress was made in process development by achieving good plating results at 50 ASF using the interpulse wave form. **JDL Subpanel:** Electronics

POC: Ron Bing
WL/MTMC
(937) 255-2461

Frequency Conversion Material Producibility

(Page 33) Contract Number: F33615-93-C-4300 ALOG Number: 613

Update - Two temperature process has been established and is now being refined by DOE. Laser testing has begun. **JDL Subpanel:** Electronics

POC: P. Michael Price
WL/MTMC
(937) 255-2461

Infrared Focal Plane Array Flexible Manufacturing

(Page 34) Contract Number: F33615-93-C-4320 ALOG Number: 1173

Update - The interim production run is in progress. The factory integration and process refinement has progressed to the point where some of the interim runs will be accomplished on the new six-inch flexible manufacturing line. In addition, the Amber design tool for read-out circuits is progressing satisfactorily. **JDL Subpanel:** Electronics

POC: P. Michael Price
WL/MTMC
(937) 255-2461

Active Projects

Manufacturing Technology for Multi-Band Gap Solar Cell Array

(Page 37) Contract Number: F33615-95-C-5508 ALOG Number: 1278

Update - Average lot efficiency has increased to greater than 23 percent for multi-junction solar cells. **JDL Subpanel:** Electronics

POC: P. Michael Price
WL/MTMC
(937) 255-2461

Manufacturing Technology for Multi-Band Gap Solar Cells

Contract Number: F33615-95-C-5561 ALOG Number: 1465

Update - Average lot efficiency has increased to greater than 23 percent for multi-junction solar cells. Efficiencies of near 26 percent have been demonstrated. **JDL Subpanel:** Electronics

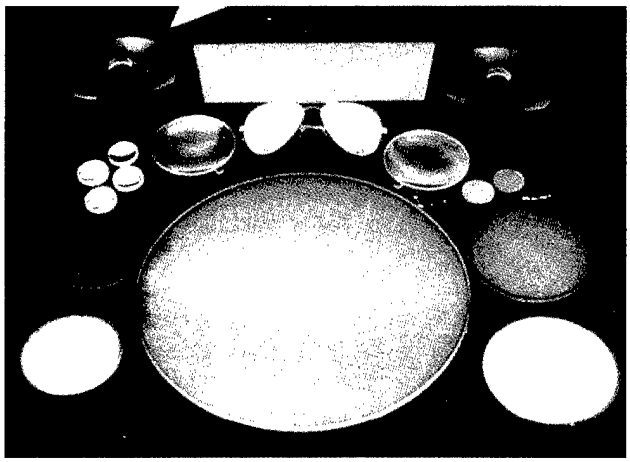
POC: P. Michael Price
WL/MTMC
(937) 255-2461

Manufacturing Technology for Tactical Grade Fiber Gyroscopes

(Page 38) Contract Number: F33615-93-C-4321 ALOG Number: 405

Update - Existing operations were baselined and assembly flow and cost model information were used to benchmark the effort and to develop a detailed program plan and cost model. Variability reduction techniques were applied in conjunction with automation and semi-automation to the respective component assembly areas. Progress towards program goals was verified with an intermediate gyro production build. Thirty gyros were built, all of which met cost and performance specs. **JDL Subpanel:** Electronics

POC: Persis Elwood
WL/MTMM
(937) 255-2461



Rugate Coating Producibility

(Page 41) Contract Number: F33615-93-C-5317 ALOG Number: 411

Update - The baseline production run and Phase I process improvements are complete. The task will establish the capability to reproducibly fabricate affordable, high performance rugate coatings. Task goals are a 50 percent reduction in number of components rejected, a 500 percent increase in component throughput, and a 50 percent reduction in component cost. **JDL Subpanel:** Electronics

POC: Capt Scott Montgomery
WL/MTMC
(937) 255-2461

Smart Electron Cyclotron Resonance Plasma Etching

(Page 42) Contract Number: F33615-92-C-5972 ALOG Number: 412

Update - Phase II is in progress. The prototype is complete. Test and evaluation is underway. Benefits include shorter cycle time for processing base contract of engineering thin film structures, and versatile, robust dry plasma etching capability for semiconductor processing. **JDL Subpanel:** Electronics

POC: Capt Scott Montgomery
WL/MTMC
(937) 255-2461

Strategic Packaging for Single & Multi-Chip Modules Using Very Small Peripheral Arrays

Cooperative Agreement Number: F33615-96-2-5110 ALOG Number: 1468

Objective

The primary objective of this program is to design, develop, and produce a family of very small peripheral array-based semiconductor packages.

Approach

This project is proposed as a three-year effort. The Defense Advanced Research Projects Agency (DARPA) has funded the first year of the effort with an option to fund the second year, depending on the results of Phase I. The first-year effort will complete the design, development and testing of the initial single chip package technology, develop automated manufacturing processes that provide a significant reduction in assembly cost, and demonstrate fully automated chip placement and wirebonding as well as an encapsulation process. The contractor will then insert a very small peripheral array (VSPA) into a real application and measure user acceptance and field reliability.

Benefits

This program will demonstrate the viability of very small peripheral arrays and ensure the reliability of the technology.

Status

New start
Start date: August 1996
End date: September 1997

Resources

Project Engineer: **Robert Cross**
WL/MTMC
(937) 255-2461

Contractor: The Panda Project

JDL Subpanel: Electronics

DARPA Funded

Electrostatic Printing of High Definition Microstructures for Flat Panel Displays

Contract Number: F33615-96-C-5104 ALOG Number: 1475

Statement of Need

Flat panel display technology must be developed in the United States so that the displays required by the military are available from domestic sources. This program, under the Defense Advanced Research Projects Agency (DARPA) auspices and managed by Wright Laboratory's Manufacturing Technology Directorate, will help develop the manufacturing equipment, processes and materials necessary to help establish the domestic manufacturing capability for flat panel displays. The objective of this program is to develop the manufacturing technology for the electrostatic printing of microstructures that consist of metal particles in the submicron to 1 or 2 micron range and glass/ceramic particles in the 1 to 5 micron range. These particles will be fused or reflowed together for use in a broad range of display applications. A specific task of the program is the design of a developmental electrostatic press to print these liquid toners onto glass or ceramic substrates in non-contact mode.

Approach

This effort consists of designing and building a developmental electrostatic printing press to image fine features on small (approximately 50mm x 50mm) silicon, glass or ceramic plates. A major subset of this effort will the formulation of toners, metallic particle liquid toners and glass/ceramic particle liquid toners for use in the above machine. These will be imaged by the developmental press and microstructures produced on the small plates.

Benefits

This program will help reduce the cost of manufacturing military displays.

Status

Active
Start date: July 1996
End date: September 1997

Resources

Project Engineer: **Tony Bumbalough**
WL/MTMM
(937) 255-2644

Contractor: Electrox Corporation

JDL Subpanel: Electronics

DARPA Funded

Self Orienting Fluidic Transport Assembly

Contract Number: F33615-96-C-5111 ALOG Number: 1448

Statement of Need

Flat panel display technology must be developed in the United States so that the displays required by the military are available from domestic sources. This is a program, under the Defense Advanced Research Projects Agency (DARPA) auspices and managed by the Wright Laboratory Manufacturing Technology Directorate, which will develop the manufacturing equipment, processes, and materials necessary to establish the domestic manufacturing capability for liquid crystal displays. The primary objective of this program is to develop a process for the manufacture of high information content displays by fluidic self assembly. The specific objective of this program shall be the development of a process for economical high volume manufacture of the active matrix portion of an active matrix liquid crystal display using fluidic self assembly of foundry silicon.

Approach

This is a two-phased program with Phase I being the basic program and Phase II as an option. Phase I will focus on laboratory demonstration of the processes involved. The entire program will develop a complete, scaleable and manufacturable prototype process for the manufacture of active matrix assemblies by fluidic self assembly of foundry single crystal silicon, suitable for further processing into active matrix liquid crystal displays using conventional LCD technology.

Benefits

This effort will result in higher performance and lower cost of military displays.

Status

New start
Start date: September 1996
End date: January 2000

Resources

Project Engineer: **Tony Bumbalough**
WL/MTMM
(937) 255-2644

Contractor: Beckmen Display Inc.

JDL Subpanel: Electronics

DARPA Funded

EcoBoard: A Tool for the Design of Green Printed Circuit Boards and Assemblies

Cooperative Agreement Number: F33615-95-2-5548 ALOG Number: 1388

Statement of Need

The market share of the United States' printed circuit board (PCB) manufacturers has steadily declined from 40 percent in 1980 to 29 percent today, and there is increasing competitive pressure from low cost foreign producers. The competitiveness of the U.S. PCB and assembly industries is significantly impacted by environmental concerns related to the production, use, and disposal of industry products. In addition, the generation of manufacturing by-products and the disposal of outdated or malfunctioning electronics systems are increasing technical and financial concerns for the Department of Defense. While many companies still rely on end-of-pipe solutions to environmental problems and expend considerable resources to meet regulations generated by governmental agencies, it is clear today that addressing these issues early and rapidly in product development has significant payoffs.

EcoBoard is a computer-based tool for probing the environmental impact of evolving PCB products and processes. EcoBoard will enable a rational assessment of the environmental impact of PCB products and processes throughout the development process. It is based on a holistic approach to the assessment of the environmental impact of systems that accounts for uncertainties in system parameters and regulations and provides the capability to easily define the scope and the depth of the analysis.

Approach

This effort is a focused, cost-shared, cooperative industry effort to develop and demonstrate an innovative Design for Environment (DFE) software package called EcoBoard, for the design of green printed circuit boards (PCB) and PCB assemblies. The active participation of a mainline computer-aided design (CAD) supplier, with the core technology developer and industry users, will lead to a rapidly deployable, customer-focused DFE tool. EcoBoard will work in concert with existing design tools, development processes and business practices. It will incorporate unique software and analytical features that will allow designers to actively consider environmentally sound product and process choices in conjunction with performance and cost considerations. The applicability of EcoBoard in the design of real electronic systems will be established through demonstrations. The greening of a PCB product or process, in terms of lower estimates of life-cycle energy consumption or hazardous waste material generation, will become transparent to a design engineer using EcoBoard.

Status

Active
Start date: August 1995
End date: August 1997

Benefits

EcoBoard solves the problem of scope and complexity of environmental analyses, making it practical for designers to assess environmental impact. The critical tradeoff in an environmental analysis is between the time and cost of a comprehensive, detailed assessment and the uncertainty introduced when parts of the life cycle impact are approximated. EcoBoard solves this problem by assessing the strength of links between design choices and environmental impacts. Relatively unimportant links are pruned from the analysis search tree and replaced with a range of values representative of contingencies that would be found in a detailed assessment. EcoBoard accounts for this uncertainty and extends it back to reflect uncertainty in top-level environmental impact metrics.

Resources

Project Engineer: **Ron Bing**
WL/MTMC
(937) 255-2461

Contractor: Science Applications International Corp

JDL Subpanel: Electronics

DARPA Funded

Affordable Integrated Optic Chips

Contract Number: F33615-96-C-5625 ALOG Number: 1458

Statement of Need

The overall goal of this Small Business Innovation Research (SBIR) effort is to reduce the cost of pigtailed integrated optic chips (IOCs), which are a key component used in fiber optic gyros (FOGs), to less than $100 in large volume production (6000 inertial measurement units (IMUs) per year).

Approach

The contractor will document the macro-flow and micro-flow for existing fabrication processes. The preliminary cost model will be analyzed, and a two-level quality function deployment (QFD) matrix will be developed. The program plan will include a variability reduction roadmap showing how tools (such as design of experiments, quality function deployment, and statistical process control) will be used to obtain programmatic goals. This program will culminate in a feasibility demonstration to provide confidence in the approach.

Benefits

Fiber optic gyros have numerous applications in both the commercial and military markets, primarily in the area of navigation (automobiles, airplanes, and ships).

Status

New start
Start date: April 1996
End date: October 1997

Resources

Project Engineer: **Ron Bing**
WL/MTMC
(937) 255-2461

Contractor: Ramar Corporation

JDL Subpanel: Electronics

SBIR Funded

Low-Cost Alignment-Free Pigtailed Integrated Optic Chip (IOC) for Fiber Optic Gyros

Contract Number: F33615-96-C-5623 ALOG Number: 1459

Statement of Need

The overall goal of this Small Business Innovation Research (SBIR) effort is to reduce the cost of pigtailed integrated optic chips (IOCs), which are a key component used in fiber optic gyros (FOGs), to less than $100 in large volume production (6000 inertial measurement units (IMUs) per year). The program will target tactical and navigational grade applications and will address manufacturing improvements in the following areas: wafer/chip manufacturing, chip end face preparation, fiber preparation, fiber chip attachment, and packaging.

Approach

The program approach will be conducted in five tasks. Task I will investigate the architecture and fabrication technique for the nonlinear optical (NLO) polymer integrated optic chips. Task II will investigate the alignment-free pigtailing method for NLO polymer IOCs. Task III will survey the material properties and performance of the state-of-the-art NLO polymers, and identify the materials that meet the requirements. Task IV will choose a preliminary design, then analyze and evaluate the performance of IOCs. In Task V a program plan will be developed to predict the cost of the integrated optic chip fabrication, and determine the quality control procedures.

Benefits

Fiber optic gyros have numerous applications in both the commercial and military markets primarily in the area of navigation in automobiles, airplanes, and ships. This effort will produce a class of highly reliable, low cost, alignment-free fiber pigtailed integrated optic chips for fiber optic gyroscope applications.

Status

New start
Start date: April 1996
End date: October 1997

Resources

Project Engineer: **Ron Bing**
WL/MTMC
(937) 255-2461

Contractor: TACAN Aerospace Corporation

JDL Subpanel: Electronics

SBIR Funded

Instrument for Rapid Quantitative and Nondestructive Wafer Evaluation

Contract Number: F33615-96-C-5108 ALOG Number: 1461

Statement of Need

The importance of detecting and identifying sub-micron defects is due to the present move by the semiconductor industry to manufacture integrated circuits with feature sizes of 0.5 μm, and in the near future with features sizes of 0.25 μm or less. The latter will require the detection of 2 nm substrate defects to 20 nm sized particles on unpatterned silicon wafers. In addition, the industry is scaling up from 200 mm to 300 mm diameter wafer which will require fewer defects and rapid detection per wafer at all processing stages. To have higher yields, defect data must be processed rapidly in real-time to correct processing problems through statistical process control techniques. The objective of this Phase II Small Business Innovation Research (SBIR) project is to develop a rapid in-process wafer surface defect measurement system that can inspect large surface areas in a non-intrusive, non-contact manner to determine the quality of wafer surface.

Approach

The approach is to take the Phase I breadboard of the heterodyne optical scanning scatterometer and refine it into a commercial product through extensive requirements definition, system design and prototyping and design of experiments evaluation. The system will be beta tested by SEMATECH and other semiconductor manufacturers.

Benefits

The payoff will be significantly reduced cost and improved quality and reliability of semiconductor devices by identifying defective wafers prior to semiconductor integrated circuit processing.

Status

Active
Start date: July 1996
End date: November 1998

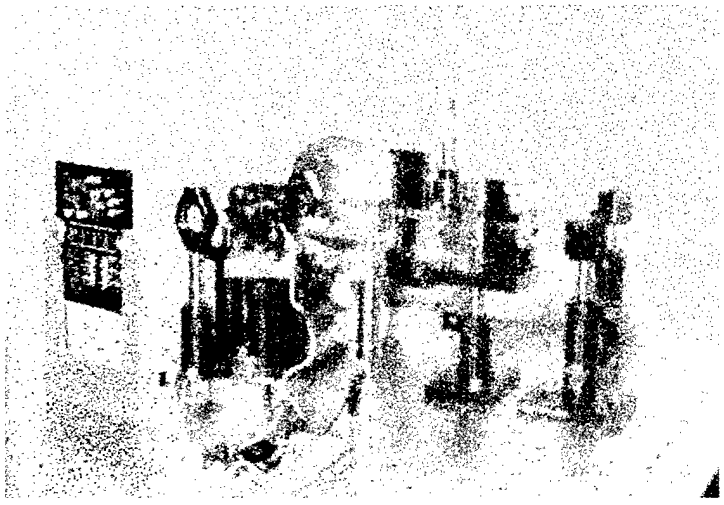
Resources

Project Engineer: **Charles Strecker**
WL/MTMC
(937) 255-2644

Contractor: Sentec Corporation

JDL Subpanel: Electronics

SBIR Funded



Airborne Warning & Control System (AWACS) Salvageable Electron Gun

Contract Number: F33615-96-C-5103 ALOG Number: 1464

Statement of Need

At the present time, when the vacuum integrity of an airborne warning and control system's (AWACS) klystron power amplifier (KPA) is damaged or destroyed, the KPA can be repaired, rebuilt and made serviceable once more. If the need is there, the KPA can be rebuilt several times. Unfortunately, each and every time the vacuum integrity of the KPA is lost, the electron gun must be removed and scrapped. If the KPA is to be rebuilt, it must have a new electron gun.

The electron gun used in the AWACS KPA uses an oxide coated cathode. This means that the electron emission surface of the cathode is applied to a substrate. The cathode coating material is converted from a mixture of carbonates to a mixture of oxides. The conversion occurs at high temperature during the exhaust/bakeout processing of the KPA. The conversion is necessary to provide a material that readily emits electrons. Once the conversion has taken place, the oxide emission material will be destroyed if it is subjected to any amount of air. It cannot be reprocessed and made useful again. This electron gun also must use grids to control the electron beam emitted from it. The cathode is coated, and then the grids are installed. The mechanical design of the electron gun is such that these grids cannot be removed without inflicting irrepairable damage to the electron structure. Thus, every time the KPA loses its vacuum, the electron gun must be scrapped. The method of attachment of the electron gun to the high voltage insulator provides a structure that does not permit the electron gun to be separated from the insulator assembly without excessive damage to both. This results in the scrapping of the insulator assembly each time the electron gun is removed from the KPA.

Approach

A manufacturing process improvement will demonstrate the successful removal of the electron gun from the high voltage insulator assembly, and the removal of the grids, thus allowing for repair. The current manufacturing process will be baselined through design of experiments and statistical process control methodologies to improve the process and monitor validation of the process improvement.

Benefits

The initial benefit is that it will reduce the cost of the KPA by the number of electron guns that are reused instead of scrapped and replaced. This would result in a lower cost to the customer. Eventually, as the existing guns in the Air Force KPA inventory are replaced through repair programs, the cost of KPA repair will go down as a result of the ability to reuse a significant percentage of the electron guns.

Status

Active
Start date: July 1996
End date: November 1997

Resources

Project Engineer: **P. Michael Price**
WL/MTMC
(937) 255-2461

Contractor: Litton Corporation

JDL Subpanel: Electronics

Real-Time FT-IR Diagnostics and Control of Semiconductor Fabrication

Contract Number: F33615-95-C-5545 ALOG Number: 1426

Statement of Need

The primary goal of the semiconductor industry is to increase device density and lower per circuit cost, while increasing yield and throughput. The most direct method to achieve this goal is through real-time process monitoring and control. The reduction in the time for obtaining high yields for new semiconductor products is particularly attractive given military requirements for high priority components in small quantities at low costs. Only a few projects have been initiated dealing with in-line or in in-situ sensing. These sensors, using ellipsometry, reflectometry, pyrometry, and emission spectroscopy provide limited data and have not been widely used. More versatile sensors and the control technology that uses the sensor data are needed to achieve the potential benefits of improved manufacturing. The ultimate goal of this Phase II Small Business Innovation Research (SBIR) program is to develop the diagnostic and control technology (sensors and models) for electronic material layer growth processes. This technology will allow control of processing temperature, film thickness, doping and composition profiles using FT-IR (Fourier Transform-Infrared) reflectance, radiance, or ellipsometry data.

Approach

This project will integrate FT-IR spectroscopy with electronic wafer manufacturing devices and employ rapid computer analysis models and algorithms to provide in-situ and real-time monitoring for feedback process control. Key activities include developing:

- Models for multilayer reflectance, dielectric function, and interface layer profiles
- An FT-IR sensor which can simultaneously measure reflectance, radiance & ellipsometry data
- An FT-IR wafer mapping system for off-line developments of measurement techniques and models
- A sensor/cluster tool interface and control surface model for wafer-by-wafer control of epitaxial silicon fabrication
- A sensor/MBE tool interface and control model for monitoring and control of HgCdTe production and other electronic materials

Benefits

This project will:

- Increase yield and throughput
- Reduce the need for test wafers
- Decrease operating & testing manpower needs
- Decrease reactor downtime
- Shorten development cycles

Resources

Project Engineer: **Capt Scott Montgomery**
WL/MTMC
(937) 255-2461

Contractor: Advanced Fuel Research, Inc.

JDL Subpanel: Electronics

SBIR Funded

Status

Active
Start date: September 1995
End date: January 1998

Modeling for Sensor-Based Semiconductor Process Control

Contract Number: F33615-95-C-5543 ALOG Number: 1426

Statement of Need

Many processes in the semiconductor industry require precise control of temperature. Therefore, an accurate model of the process that includes all the major physical parameters that govern the behavior of the system would be a valuable tool. In addition, there is no commercially available, semiconductor fabrication equipment that uses model-based feedback control systems for adjusting process inputs to compensate for variations and disturbances. For instance, rapid thermal processing (RTP) chambers have not taken off as expected due to temperature uniformity and repeatability problems. These problems can certainly be resolved with a model based feedback control system. The goal of this Phase II Small Business Innovation Research (SBIR) program is to create a comprehensive graphical modeling tool for thermal systems and develop control design techniques to address a broad class of thermal problems.

Approach

The objective of this program is twofold: 1) develop the techniques and software tools needed to create detailed physical models of the processes typical of semiconductor fabrication; and 2) develop sensing and control algorithms based on the physical models. The program will:

- Develop a graphical model building software tool
- Create techniques for developing advanced multivariable model-based control systems
- Build a graphical user interface to make the software easy to use
- Demonstrate the modeling tool by developing a physical model of a commercial RTP chamber
- Develop and demonstrate a model-based multivariable real-time control system for the RTP chamber
- Develop a generic thermal modeling prototype commercial software product

Benefits

This program will:

- Eliminate the need for intimate knowledge of modeling and control design algorithms
- Allow rapid repetitive design iterations
- Enable seamless interaction with a real-time implementation environment
- Provide capabilities not currently available with commercially available modeling or Computer Aided Control Engineering (CACE) tools

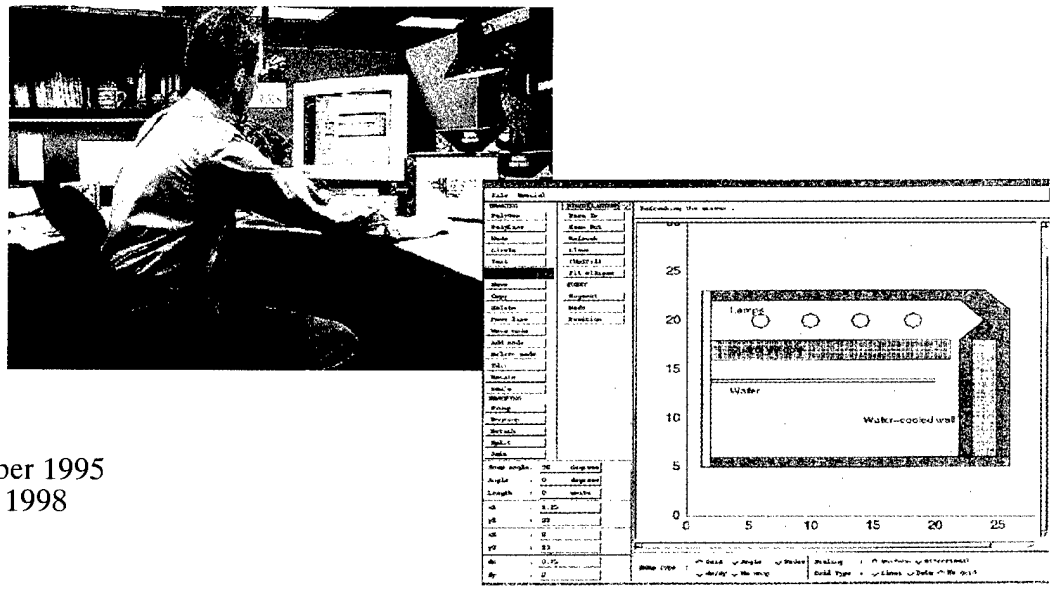
Resources

Project Engineer: **Capt Scott Montgomery**
WL/MTMC
(937) 255-2461

Contractor: Integrated Systems, Inc.

JDL Subpanel: Electronics

SBIR Funded



Status

Active
Start date: September 1995
End date: January 1998

Completed Projects

Agile Manufacturing Information Infrastructure

(Page 48) Contract Number: F33615-94-C-4400 ALOG Number: 218
Technical Report Number: In progress

Four working groups were briefed on the technical direction of the project for feedback. This program was completed in August 1996. Final report completed in October 1996. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Brian Stucke
WL/MTII
(937) 255-7371

Multi-Chip Module Infrastructure Development

(Page 62) Contract Number: F33615-93-C-5315 ALOG Number: 135
Technical Report Number: In progress

This effort developed design and test automation tools for digital multi-chip modules (MCM). Tester independent translation tools are available on the world wide web to aid in the targeting of design test information to target manufacturing and support test equipment. In addition, AC and DC parametric analysis tools were developed and commercialized. The project was completed in December 1995. **JDL Subpanel**: Manufacturing and Engineering Systems

POC: Bill Russell
WL/MTII
(937) 255-7371

Open Matrix Distributed Software System

(Page 63) Contract Number: F33615-93-C-5314 ALOG Number: 230
Technical Report Number: In progress

This program designed a Network Services Tool Kit which enables on-line, interactive use of network-based design aids and manufacturing expert systems. The Open Matrix project has completed several key software developments which have contributed to the expanded usage and capability of the Internet. Secure Hyper Text Transfer Protocols is just one of the software services developed by the Open Matrix project and is a key technology for the expanded use of the Internet for electronic commerce. Other key developments included embedding multiformat messages in E-mail for successful transfer and security and E-mail archiving capability. In all, over ten software components were developed to take advantage of the existing Internet infrastructure to support engineering collaboration and network-based design aids. This program was completed in June 1996. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Brian Stucke
WL/MTII
(937) 255-7371

Rapid Application Specific Electronic Modules Design and Test

(Page 67) Contract Number: F33615-93-C-4309 ALOG Number: 114
Technical Report Number: In progress

This project developed a prototype university fault simulation tool set for digital microcircuits. The resultant product is in the process of being made available as a commercial offering. The process and accuracy of fault simulation have been significantly advanced by this CAD tool. The project was completed in February 1996. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Bill Russell
WL/MTII
(937) 255-7371

Active Projects

Activity-Based Costing for Agile Manufacturing Control

(Page 44) Contract Number: F33615-95-C-5516 ALOG Number: 1361

Update - Models have been finalized and delivered for five of the six companies. Caratron's model was completed and given to Caratron. The model for Chivas was presented to them in April. We have worked with them to update that model to reflect some changes made in production. We are updating PSI's model with the current budget numbers, and APP is considering making some modifications to their model. We have given some post-model training to all the companies but Chivas and Caratron on uses of the model. The project was extended 6 months, so the active project end date is now January 31, 1997. Training courses and seminars about ABC have been developed, and we are in the process of writing up individual case company descriptions. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Cliff Stogdill
WL/MTII
(937) 255-8589

Advanced Collaborative Open Resource Network

(Page 45) Contract Number: F33615-94-C-4450 ALOG Number:1381

Update - Subcontractor selection completed March 3, 1995. Began work on the first demonstration of ACORN. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Brian Stucke
WL/MTII
(937) 255-7371

Advanced Tools for Manufacturing Automation and Design Engineering

(Page 46) Contract Number: F33615-94-C-4427 ALOG Number: 1246

Update - A critical design review was held. Specification and methodology are complete. Software tool development is 80 percent complete, library creation is 60 percent, and integration, evaluation and testing are at midpoint. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Daniel Lewallen
WL/MTIM
(937) 255-7371

Below-A-Minute Burn-In for Known Good Die

(Page 51) Contract Number: F33615-94-C-4432 ALOG Number: 1270

Update - This technical effort was originally scheduled to end April 1996, but due to a modification the program was extended to March 1997. Extensive demonstrations of the initial prototype system are underway with 4,000 memory microcircuits from a domestic manufacturer. Results of the demonstration efforts are due in January 1997. **JDL Subpanel**: Manufacturing and Engineering Systems

POC: Bill Russell
WL/MTII
(937) 255-7371

Active Projects

Continuous Electronics Enhancements Using Simulatable Specifications

(Page 52) Contract Number: F33615-93-C-5078 ALOG Number: 220

Update - The CEENSS Revision 1 of the methodology has been approved by the Industrial Review Board at the Critical Design Review for development of Build 1 to be completed 1 Nov 96. CEENSS Tool Set Review was accomplished September 1996, also in preparation of Build 1. Commercial Products from Mentor Graphics are being modified to accommodate the CEENSS strategy. The VSPEC language, from RASSP, is being modified to provide an executable specification language in conjunction with VHDL IEEE 1076. CEENSS has been showcased at DMC '95, DMSMS '96 and NAECON '96. Numerous technical papers on CEENSS were published and are available through the Manufacturing Technology Directorate Technology Transfer Center. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Alan Winn
WL/MTIM
(937) 255-7371

Flexible Environment for Conceptual Design, Geometric Modeling and Analysis and Assembly Process Planning

(Page 53) Contract Number: F33615-94-C-4426 ALOG Number: 1245

Update - Papers on Dewar assembly plans have been presented. A MADE workshop was held at Stanford University. I-DEAS communication established and the prototype "ring" scenario is operational. CORBA-compliant design sheet interface is constructed and operational. FLIR-92 IRFPA/Dewar/Seeker Design Sheet model with basic geometry completed. Seeker design scenario is operational, showing great promise of approach. Draft project report has begun. Significant progress has been made towards developing an IRFPA/Dewar assembly process planning system. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Daniel Lewallen
WL/MTIM
(937) 255-7371

Integrated Process Planning/Production Scheduling

(Page 54) Contract Number: F33615-95-C-5523 ALOG Number: 1368

Update - Phase I is complete. Phase II development activities to implement the integration architecture are stable and progressing. The process planning module and the production scheduling module have passed initial implementation tests. Analysis capability and predictive/reactive planning experiments are being incorporated into the blackboard architecture. A production implementation within the Raytheon Andover Plant is being planned. Final demonstration in the Andover production site was conducted on October 18, which marked the end of the program technical activity. **JDL Subpanel**: Manufacturing and Engineering Systems

POC: John Barnes
WL/MTIM
(937) 255-7371

Integrated Product Processing Initiative

(Page 55) Contract Number: F33615-93-C-5319 ALOG Number: 209

Update - Technical Activity has been completed for the program. The products include the MicroBoss manufacturing and production scheduling tool and STEP standard advancement in the areas of shop floor production control. These products were demonstrated in conjunction with the IP3S final demonstration on 18 October 1996. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: John Barnes
WL/MTIM
(937) 255-7371

Active Projects

Large Scale System Simulation and Resource Scheduling Based on Autonomous Agents

(Page 58) Contract Number: F33615-95-C-5524 ALOG Number: 1339

Update - A subset of the parts have been classified as "Rotational Large" as a result of the cluster analysis on the factory, comparative evaluations of various other factory areas, and discussions with the Rock Island Arsenal personnel. The contractor has identified the cost centers, machine groups, and parts involved in Rotational Large. Data has been collected on the number of machines in each machine group, and the amount of time each machine group spends on a given part. For each operation on each part, data has been collected on the materials, machines, and class of operators involved, the set-up and running time. Based on these studies, a subset of the parts for scheduling have been identified. Agent Infrastructure - considerable effort has been spent in designing a flexible, robust, and high performance infrastructure in order to support implementation of agent-based applications on distributed computer systems. The infrastructure has been implemented and is currently in alpha stage. A programmer's manual has been prepared and all the team members have been trained in the usage of the infrastructure. **JDL Subpanel**: Manufacturing and Engineering Systems

POC: James Poindexter
WL/MTIM
(937) 255-8589

PDES Application Protocol Suite for Composites

(Page 64) Contract Number: F33615-91-C-5713 ALOG Number: 177

Update - Technical activity on all application protocols is complete and final preparations for the Final Contract Demonstration are nearing completion. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: John Barnes
WL/MTIM
(937) 255-7371

PDES Application Protocols for Electronics

(Page 65) Contract Number: F33615-91-C-5718 ALOG Number: 179

Update - Information models and protocols are complete. The demonstration of an initial CAD and test compliant tool set is currently in process. Early results have demonstrated a 25 percent reduction in the test program set development process when driven with CAD information provided via the developed protocol. The information modeling process utilized to harmonize the test standards has been adopted by the standards community as the most appropriate methodology for standards harmonization. The developed information modeling approach is currently being applied to harmonized CAD and CAM standards for the printed circuit board industry. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: Bill Russell
WL/MTII
(937) 255-7371

Strategic Planning and Operating Tools for Agile Enterprises

(Page 68) Contract Number: F33615-95-C-5514 ALOG Number: 1363

Update - This program developed and tested a family of strategic planning and operating tools for the formation, operation, and dissolution of virtual enterprises. **JDL Subpanel:** Manufacturing and Engineering Systems

POC: George Orzel
WL/MTII
(937) 255-7371

Active Projects

Thoroughly Testing Known Good Die

(Page 69) Contract Number: F33615-94-C-4401 ALOG Number: 1186

Update - The proof of concept demonstrations have proven the effectiveness of on-board test structures to facilitate at-speed testing of multi-chip modules. The developed test structures are now in the process of design shrink to macrocells for embedding in individual microcircuits, substrates and tester test heads. There will be a press release by the contractor at the 1996 International Test Conference on their plans to bring this new technology and associated automation tools to market. **JDL Subpanel:** Manufacturing and Engineering Systems

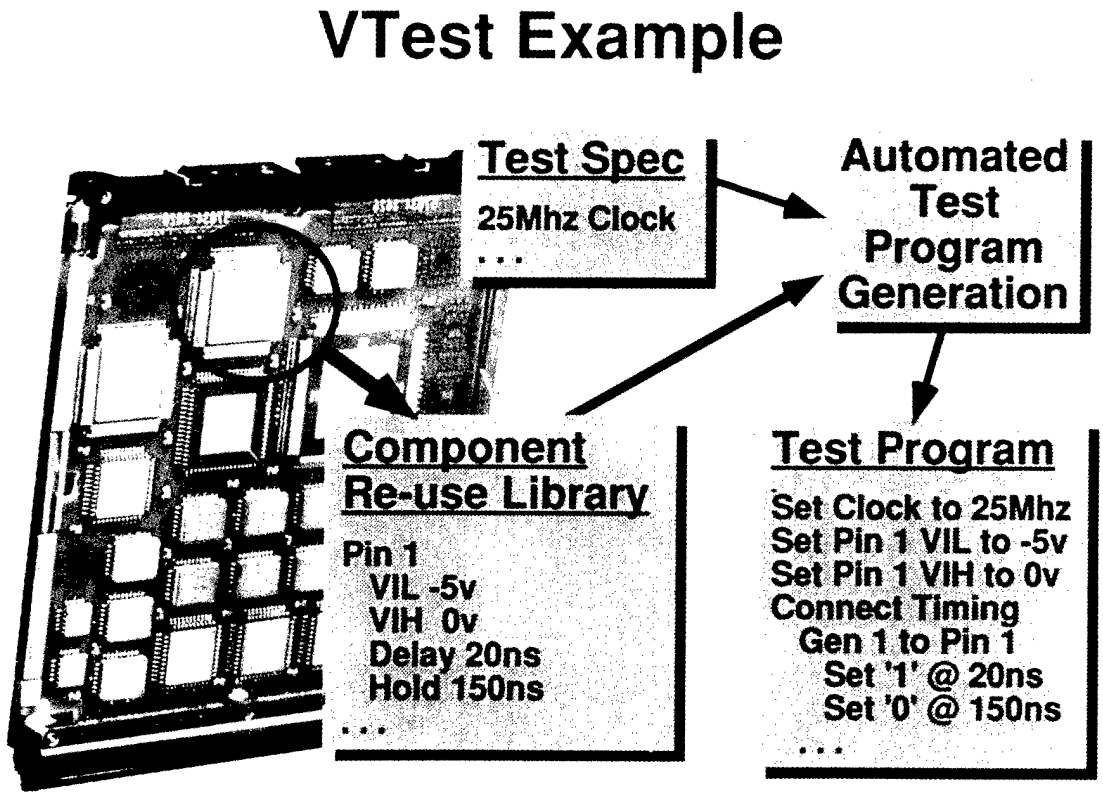
POC: Bill Russell
WL/MTII
(937) 255-7371

Virtual Test

(Page 70) Contract Number: F33615-93-C-4308 ALOG Number: 221

Update - Phase I, assessment and planning is complete. Phase II, develop Virtual Test System, has begun. **JDL Subpanel:** Manufacturing and Engineering Systems.

POC: Daniel Lewallen
WL/MTIM
(937) 255-7371



Reasoning in 3-Dimensions: A Common Framework for Design, Manufacturing and Tactical Planning

Contract Number: F33615-95-C-5560 ALOG Number: 1382

Statement of Need

Historically, knowledge based systems have not been linked to geometric structural representation. Knowledge-based analysis, advising, and planning systems have been successfully applied in domains where three-dimensional geometric reasoning was not a critical element. Large rule-based systems and learning systems operated in domains where pieces of knowledge could well be expressed by if-the-else productions. Knowledge involving complex three-dimensional geometric arguments is difficult if not impossible to represent in a traditional rule-based paradigm. Object abstraction utilizing dimensional reduction techniques such as skeletonization and spatial decomposition is crucial for geometric reasoning. Skeletal representations capture the essence of shapes very effectively. Spatial decomposition reduces geometric complexity by slicing three-dimensional objects into thin cross-sectional layers and reducing three-dimensional objects into near 2.5-D objects. A wide spectrum of important applications requires detailed analysis of spatial alternatives before suggesting possible plans of action. Design and manufacturing is an application domain where geometry is known to be crucial. A new class of manufacturing processes based on spatial decomposition takes advantage of the reduced geometric complexity and the removal of such issues as access and fixturing found in conventional machining. Tactical planning for military operations is also an application domain. It requires the understanding of spatial constraints as well as space-time relations. Current planning systems largely ignore three-dimensional spatial considerations. With the employment of skeletal transformations, planning of ground and air campaigns could be dramatically improved.

Approach

This effort will develop agent-based computation tools for dimensionally reducing and decomposing three-dimensional solid geometries. The software developed will be modular and will have links to standard interfaces such as PDES (Product Data Exchange using STEP). The software will be linked to applications through integrative frameworks. Algorithms for rapid discretization, digital thinning, post processing of digital skeleton, feature classification, compact splitting and spatial decomposition of three-dimensional solid geometries will be developed and tested. Testing shall be conducted in two phases: testing the algorithm with simple parts, and testing the algorithm with complex parts. The post processing and compact splitting algorithms will be evaluated for applicability to tactical scenarios.

Status

Active
Start date: September 1995
End date: September 1998

Benefits

Dramatically improve use of knowledge-based approaches in design and manufacturing applications.

Dramatically improve planning of military ground and air campaigns.

Resources

Project Engineer: **Jon Jefferies**
WL/MTII
(937) 255-8589

Contractor: Stanford University

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

JSF Technology Manufacturing Capability Assessment Toolset

Contract Number: F33615-95-C-5527 ALOG Number: 1340

Statement of Need

The early consideration and management of manufacturing risk in technology development is critical to the Joint Strike Fighter (JSF) initiative. A manufacturing capability requirements (MCR) assessment already exists. The MCR process results in a detailed system-requirements, technology-process profile. This profile defines technology development and maturation efforts with recommendations to resolve identified manufacturing deficiencies based on analysis of collected information. However, a need exists to computerize this methodology and extend it to identify, quantify, and capture key manufacturing processes, critical characteristics, and capability indices.

The objective of this program is to develop and implement an approach which defines the format and content of JSF information used in the MCR process, computerizes the MCR assessment methodology, and extends the process. This extension will include, but not be limited to, six-sigma design concepts, process capability, process variability, critical characteristics, predicted first-time yield, and defects per unit. In addition, information collected during the assessment will be organized so a software toolset can be used in conjunction with the MCR methodology to perform a structured assessment of product and process maturity technology options for subsystems or systems.

Approach

The program will use a series of mini-workshops involving all members of the JSF Manufacturing Capability Assessment Toolset (JMCATS) team. The members consist of government personnel and representatives from Boeing, GEAE, Hughes Radar and Communication Systems, Lockheed Martin, McDonnell Douglas Aerospace, Northrop Grumman, Rockwell Collins, and Texas Instruments. The objective of the workshops is to allow the members to develop an overall methodology and set of software requirements for JMCATS. The team members will also identify users at their companies to further develop the software prior to final release. Training for the users will accompany each release of the software. Three versions of JMCATS software will be developed with the final version available to all members of the JSF community.

Status

Active
Start date: April 1995
End date: December 1996

Benefits

The payoff of this effort is to develop and demonstrate a methodology and software toolset which will enable the early identification of manufacturing risk for JSF technologies. This will ultimately facilitate the development and documentation of product and process technologies with sufficient maturity to achieve JSF objectives.

Resources

Project Engineer: **Theodore J. Finnessy**
WL/MTIM
(937) 255-8589

Contractor: **General Research Corp. International**

JDL Subpanel: **Manufacturing and Engineering Systems**

JSF funded

Joint Program in Manufacturing Research with the National Science Foundation

Contract Number: numerous ALOG Number: 1263, 1411-1414

Statement of Need

The goal is to create, through a joint effort by the Manufacturing Technology Directorate and the Division of Design and Manufacturing of the National Science Foundation (NSF), a new program of basic research in manufacturing. This initiative will focus university research on methods and tools to enhance affordability and producibility of new weapon system components.

Approach

Collaborative projects between the Manufacturing Technology Directorate and NSF are being funded to address major research issues faced by the defense industry. A new research program is expected to be identified each year and grants to universities awarded to conduct research on the issues identified in the program. Universities must have a defense industry partner who will ultimately implement the research results. The first program was initiated in September 1995, and is aimed at the broad subject of affordability of new technology. Researchers will develop and demonstrate methods and tools which can assist defense companies in their assessment and management of the cost-risk of developing and implementing new manufacturing technologies. The second program is currently being developed and will address representing forging processes for defense manufacturing.

Benefits

This program is aimed at building a better research base for defense manufacturing by focusing academians on affordability and producibility.

Status

Active
Start date: September 1995
End date: September 2001

Resources

Project Engineer: **Jon Jefferies**
WL/MTII
(937) 255-8589

JDL Subpanel: Manufacturing and Engineering Systems

Contractor:

Five grants have been awarded to the following universities as part of the initial program. The duration of all contracts is 36 months.

Life Cycle Costs of Manufacturing Activities and Technological Innovation

Texas A&M University

The goal of this research is to develop cost models, which can be used in both commercial and defense manufacturing activities, to assess and devaluate the cost impact of technological innovation and/or design changes on the product life cycle. The final deliverables will be a taxonomy/ontology/compilation of cost drivers, cost relationships, and activity-based cost models.

Decision-Making with Incomplete Information in an Integrated Product & Process Development Enterprise - A Management Decision Tool for Cost Modeling & Affordability Applications

Florida A&M, Florida State University

The goal of this research is to develop a tool for engineering managers to estimate the impact of new technologies on manufacturing and life-cycle costs, and to incorporate the estimates concurrently into engineering design with the presence of uncertainty in the estimates. This will be based on the analysis of existing technical,

human, and organizational subsystems of the total production system as well as on the feasibilty of modifications, innovations, and new technologies.

A Methodology for Promoting the Design & Justification of Innovative Solutions to Flexible Manufacturing Problems in Traditional Factories

New Jersey Institute of Technology

The goal of this research is to develop methodologies which help companies design innovative flexible manufacturing solutions, conduct a "non-traditional" economic analysis, and subsequently plan strategies for the successful implementation of the design. Flexible manufacturing (FM) concepts are known to permit a factory to: concurrently produce multiple and diverse products; upgrade and redesign its products in relatively short life cycles; and execute efficient production changeovers.

Innovation, Implementation, and Costs

Tennessee Technological University

The goal of this research is to develop a concurrent design/cost tool for management to use in the deployment of new technology. Both specific and general information will be accumulated for the development of methodologies for uncovering and estimating hidden costs of technological implementation. A framework will be developed which captures how the interrelationship between design, operational management, marketing, engineering, and employee involvement, impact costs. A groupware information system will be developed and will provide all constituents dynamic cost information to better make design/product cost tradeoffs. The framework will then be implemented on a broadbase network such as the World Wide Web to promote concurrent design and costing.

Flexible Accounting Systems in Dynamic Manufacturing Environments

Iowa State University

The goal of this research is to develop a flexible accounting system that integrates four alternative costing methodologies within the product life cycle framework. The research will link product and process technology with a dynamic cost accounting system that incorporates: target costing (product design); Kaizen costing (product introduction); standard costing (product maturity); and life cycle costing (product elimination/redesign). The accounting system will permit managers to more realistically evaluate the potential of technological innovations.

Robust Design Computational System

Cooperative Agreement Number: F33615-96-2-5618 ALOG Number: 1477

Statement of Need

Engineering tools and information integration capabilities are needed that can be used to evaluate an order of magnitude more design alternatives than is possible today. These tools and capabilities will attempt to optimize several product characteristics such as reduction of performance variability, and increased robustness and reliability.

Approach

This project will build the infrastructure and software tools for a design system called Robust Design Computational System (RDCS). The RDCS will consist of: a System Director and User Interface; Database Manager; RDCS Database; Design Processes (Probabilistic, Taguchi, Optimization, Design Scan, and Deterministic); Math Models (Cost, Manufacturing, Fatigue, CFD, FEA, and Solid); and Design Assessment and Visualization Tools (Sensitivities, Constraints, Best Design Select, Response Surface Display, and XY Plot).

The RDCS will provide an integrated product and process development team with: vastly improved ability to explore, generate, store, and analyze design alternatives; ability to numerically account for the effects of "down-stream" variability like those resulting from fabrication processes with variability inherent in the environment in which the product is used; capability to quantify the design risk, reliability, and sensitivities using a combination of deterministic and probabilistic analysis methodologies with inputs including variations such as those inherent in the loads, materials, and processes; and, capability to optimize the design for selected performance parameters (such as cost, weight, or life) over a range of variations of multidisciplinary design parameters.

Benefits

Improved product characteristics; optimized performance, robustness and reliability; and quantified design risk, reliability and sensitivities.

Status

Active
Start date: June 1996
End Date: July 1999

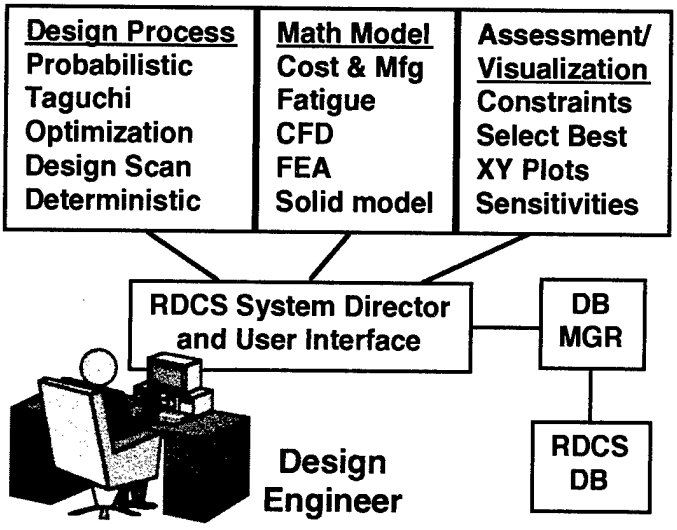
Resources

Project Engineer: **Daniel Lewallen**
WL/MTIM
(937) 255-7371

Contractor: Rockwell Rocketdyne

JDL Subpanel: Manufacturing and Engineering Systems.

DARPA Funded



Responsible Agents for Product/Process Integrated Development

Contract Number: F33615-96-C-5511 ALOG Number: 1447

Statement of Need

A designer seeks to embed a set of functions (e.g., optical, electromechanical, control) in an artifact with specified characteristics (e.g., weight, color, complexity, materials, power consumption, physical size). The functional view drives most designs, since it distinguishes the disciplines in which engineers are trained and in support of which design tools are available. Conflicts arise when different teams disagree on the relation between the characteristics of their own functional pieces and the characteristics of the entire product. Some conflicts are within the design team.

Responsible Agents for Product-Process Interactive Design (RAP/PID) is a community of agents (active software objects with varying degrees of intelligence) that help human designers manage product characteristics across different functions and stages in the product life cycle. Agents represent not only design tools and humans with a stake in the design (including designers, manufacturing engineers, and marketing and support staff), but also the components of the design itself, and the characteristic of each component. These agents trade with one another for design constraints, requirements, and manufacturing alternatives, and the resulting marketplace provides a self-organizing dynamic that yields more rational designs faster than conventional techniques.

Approach

The contractor will:

- Identify relevant design characteristics, design process information, design data flows, and characteristics for buy-and-sell prices, and provide a Knowledge Interchange Format/Knowledge Query Language and Manipulation (KIF/KQML) compatible shared data repository for this information.
- Identify and implement corresponding software information agents.
- Select an appropriate object-based development environment.
- Develop a suitable client-server environment periodically throughout its development.
- Transition RAPPID technologies to other Manufacturing Automation and Design Engineering (MADE) contractors.

Status

Active
Start date: March 1996
End date: September 1997

Benefits

The RAPPID environment will enhance a design team's ability to more thoroughly explore a product's design space, thus allowing for better optimized designs and shorter design cycle times.

Resources

Project Engineer: **James Poindexter**
WL/MTIM
(937) 255-8589

Contractor: Industrial Technology Institute

JDL Subpanel: Manufacturing and Engineering Systems

Context Integrated Design

Contract Number: F33615-95-C-5614 ALOG Number: 1446

Statement of Need

Design of complex products, with critical performance, reliability, and cost requirements, is a team effort. Teams invent, design, analyze, refine, simulate, build, test, and document the product. To perform these tasks well, they must create, distribute, interpret, and assimilate nearly overwhelming amounts of information. Designers work in a relay-team environment, in which they must transfer information through space and time, and rapid exchange and assimilation of information is essential for success.

Context Integrated Design (CID) consists of a set of software agents which work through a hypermedia shared project notebook to organize, interpret, and coordinate information in the context of the task at hand. To provide this information, the software agents must use product/process models. The development of such a model adequate for in-depth reasoning can easily consume more resources than the design of the product itself. This makes the general concept infeasible, except for products that are repeatedly redesigned. CID overcomes this problem by taking the innovative approach of providing a set of agents, each handling a modest information manipulation task. Since each agent handles a specific limited task, it needs only a specific and often rudimentary mode of some critical aspect of the product. CID uses a semiformal model embedded in an informal shared hypermedia notebook, where "semi-formal" means there is enough structure in the entry so that it is machine interpretable for certain purposes, while requiring minimal effort for construction and modification.

Approach

The contractor will:

- Develop a distributed routing mechanism consisting of an appropriate routing protocol and a CORBA compliant application programmer's interface (API).
- Specify and develop dependency, coordination, behavior, and design rationale models, model templates, and model editors.
- Identify relevant design process information and information flows, and identify and implement corresponding software information agents.
- Demonstrate the CID periodically throughout development.
- Transition CID technologies to other MADE contractors.

Status

Active
Start date: March 1996
End date: February 1998

Benefits

This program will provide mechanisms for information search, retrieval and filtering, as well as capturing design history. CID will realize participatory design methodologies through extension of the concepts of the electronic engineering notebook and agent-based engineering collaboration. The CID environment will enhance information discovery, evaluation and incorporation in a geographically distributed design environment.

Resources

Project Engineer: **James Poindexter**
WL/MTIM
(937) 255-8589

Contractor: Lockheed Martin Corporation

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Simulation Assessment Validation Environments

Contract Number: F33615-95-C-5538 ALOG Number: 1336

Statement of Need

Military aircraft manufacturing does not enjoy the traditional cost benefits of mass production because large quantities are not usually required. Separating low cost from high volume requires new approaches to product and process design and technology maturation. Virtual Manufacturing (VM) supports this concept by applying modeling and simulation technology during the design process to prove out and select optimal new concepts.

The "Simulation Assessment Validation Environments" (SAVE) program is a first step in realizing the near-term objectives common to VM and the Joint Strike Fighter (JSF) program. The objective of SAVE is to implement, demonstrate, and validate integrated modeling and simulation tools and methods used to assess the impacts of product/process decisions on the affordability of advanced strike warfare technology.

Approach

The effort is focused on initial implementations of VM strategically applied to specific real fighter and/or attack aircraft design and production affordability problems. The SAVE program consists of two phases. The goal of the Phase I demonstration is to take the user through a complete manufacturing scenario and communicate the functional capabilities of the developed tools. The Phase I demonstration will validate the core VM capabilities, identify performance and business metrics against real production problems, and point to areas for continued refinement/enhancement to be accomplished during the second phase of the program. The Phase II effort targets ongoing weapon system mechanical component or subassembly applications. Phase II culminates with a full demonstration of the developed VM capabilities applied to the targeted weapon system application.

Status

Active
Start date: April 1995
End date: August 1999

Benefits

- Affordability — Increased reliability of cost and process capability information.
- Quality — More producible designs with higher quality work instructions and fewer engineering changes.
- Producibility — Trouble-free, high-quality, first article production, involving no rework and fully meeting customer requirements.
- Flexibility — Rapid product changeovers, ability to mix production of different products, and quick return to producing previously shelved products.
- Shorter Cycle Times — Direct production without false starts.
- Responsiveness — Quicker response to customer's questions.
- Customer Relations — Improved relations through increased customer participation in the IPPD process.

Resources

Project Engineer: **James Poindexter**
WL/MTIM
(937) 255-8589

Contractor: Lockheed Martin Corp.

JDL Subpanel: Manufacturing and Engineering Systems

JSF Funded

Joint Strike Fighter Technology Manufacturing Demonstrations

Contract Number: F33615-95-C-5529 ALOG Number: 1359

Statement of Need

Current Lean Aircraft Initiative (LAI) research indicates a direct correlation between the degree of integration of cost and product/process data (design, manufacturing, supportability, and suppliers) and its use by integrated product teams. Companies with integrated cost and design databases experience better schedule and cost performance, while making more cost effective decisions. Related areas for improvement help to increase the accuracy of the cost data used to support decision making management practices, support decoupling cost from volume, and reducing cycle times. Near real time collection and feedback of cost data is cited as an enable of these capabilities. Development of these concepts requires consideration of business practice changes and infrastructure improvements. This program will develop and demonstrate improved cost/design methodologies which can be applied to the Joint strike Fighter during engineering and manufacturing development (EMD) to reduce life-cycle cost.

Approach

The contractor is developing procedures, business practices, processes and infrastructure improvements necessary to conduct product and process design using integrated cost and design data. The integrated methodologies and data will enable designers to quickly and accurately conduct design/cost trades, manufacturing process selection and cost estimation. A mini-demonstration applying the initial methodology and tools to a transmit-receive module is planned for December 1996. Phase I of the mini-demonstration showed an estimated cost savings of more than 10 percent and a 50 percent reduction in tradeoff cycle time. Targets for Phase II of the mini-demonstration include a 20 percent total reduction in tile assembly cost [excluding Monolithic Microwave wave Integrated Circuits (MMICS)]. A full demonstration is planned for 1998 using the methodology and tools on a subarray design with similar improvements anticipated. The methodology and demonstration results are available from the JSF Program office.

Status

Active
Start date: April 1995
End date: April 1998

Benefits

This effort will demonstrate transportable lean processes, practices and tool integration techniques for the JSF community. It will produce a validated methodology to reduce cost and improve schedule performance in time for widespread application within the JSF Engineering and Manufacturing Development (EMD) phase. Benefits include a potential $1.6 billion savings in JSF Radar LCC alone.

Resources

Project Engineer: **Al Herner**
WL/MTII
(937) 255-8589

Contractors: Hughes Aircraft Co.

JDL Subpanel: Manufacturing and Engineering Systems

JSF Funded

Manufacturing Simulation Driver

Contract Numbers: F33615-96-C-5609 ALOG Number: 1481

Statement of Need

The overall objective of the Manufacturing Automation and Design Engineering (MADE) program is to develop engineering tools and information integration capabilities that could be used to evaluate an order of magnitude more design alternatives than is possible today in an attempt to optimize several product characteristics, and quickly prototype complex products and processes.

Approach

Factory simulations will be created using the STEP standard as a foundation for product/process modeling, manufacturing knowledge bases and simulation engines. The MSD program will build extensions to the STEP standard that enable the capture of a manufacturing enterprise model to the level where descriptions of processes and resources are robust enough to support driving an enterprise level simulation. The STEP model will lead to the development of a software interface to a set of Deneb simulators. The program will conclude with a concept demonstration.

Status

The requirements documentation is complete and the development of the simulation tools are underway.

New start
Start date: April 1996
End date: August 1997

Benefits

The MSD program will evaluate simulation metrics, continuous product design refinements, as well as timely and cost effective design and production methods.

Resources

Project Engineer: **John Barnes**
WL/MTIM
(937) 255-7371

Contractor: Raytheon Company

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Multiphase Integrated Engineering Design

Contract Number: F33615-96-C-5621 ALOG Number: 1479

Statement of Need

The overall objective of the Manufacturing Automation and Design Engineering (MADE) program is to develop engineering tools and information integration capabilities that could be used to evaluate an order of magnitude more design alternatives than is possible today in an attempt to optimize several product characteristics, and quickly prototype complex products and processes. The objective is to provide for the development of key enabling technologies and tools to support integrated products from early stage design through manufacture for electro-mechanical parts.

Approach

The development of enabling technologies such as Design Assistants (DAs), Design-Area Encapsulations (DEs), Linked Design Alternatives, Flexible Elements, and Early Stage Features will support the transition from functional specifications to early stage assembly, shape, and engineering design through detailed design and manufacturing. This will dramatically extend the concepts of feature-based, parametric design to earlier phases in the design process and new domains.

Status

Active
Start date: March 1996
End date: March 1999

Benefits

This program will help reduce the design and manufacturing cycle for complex electro-mechanical devices.

Resources

Project Engineer: **Alan Winn**
WL/MTIM
(937) 255-7371

Contractor: University of Utah

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Process Web

Contract Number: F33615-96-C-5604 ALOG Number: 1473

Statement of Need

There is a need to rapidly configure a virtual enterprise (VE) from known, certifiable process capabilities from different team members that collectively offer the best alternative. This capability is critical to the formation of VEs, which are typically beleaguered with operating problems resulting from poor integration and mismatches between component processes of the different team members.

Approach

This effort is concerned with the development of a unique process-enabled methodology and prototype software for composing, analyzing, and debugging VE designs. A "proof-of-concept" of the overall approach will be demonstrated and evaluated within the context of a real world problem context (e.g., Multichip Module Design at Hughes Aircraft Company). The Multichip Module (MCM) is an important product in the sense that it has applications ranging from workstations to missile seekers. The MCM design process cuts across multiple disciplines and core competencies making it well suited as the initial target application. The evaluation will consist of comparing the Process-Web technology to the traditional approach. This program will develop and demonstrate an open, scaleable modeling and simulation-based methodology and software for capturing VE composing process models. At the heart of the overall VE integration approach are three new process engineering concepts: process composition, process substitution, and process mismatch analysis. This analysis methodology and software will: (1) simplify and accelerate the VE formation process and (2) produce an integrated product development process model which will serve as a guide to VE formation and operation in the real world.

Benefits

First, this approach will dramatically improve the formation and integration of a VE by allowing users to: (1) explore the impact of several VE formation/outsourcing options and (2) uncover and eliminate the serious mismatches between customer and supplier processes. Second, the resultant VE process model will serve as a guide during VE process management. Third, the manager-oriented user interface will allow users to rapidly learn and apply the tool.

Status

Active
Start date: December 1995
End date: October 1997

Resources

Project Engineer: **Cliff Stogdill**
WL/MTII
(937) 255-8589

Contractor: Intelligent Systems Technology, Inc.

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Built-In Test of Known Good Die

Grant Number: F33615-96-1-5610 ALOG Number: 1423

Statement of Need

Analog and mixed signal testing follows different test methodologies from digital testing and is a bottleneck that not only leads to high testing costs, but also causes significant 'time-to-market' delays. Testing of mixed signal modules is also exacerbated by the high chip density and small interconnect line dimensions of new multi-chip modules (MCM). Many of the conventional approaches to testing used for printed circuit boards are not applicable to dense MCM testing, for example bed-of-nails testing techniques.

Approach

This project will research and develop tools and methodologies for the automation of test pattern generation for mixed signal modules. The project will also research tools and methodologies to determine stuck and delay faults for circuits as a part of known good die development.

Status

Active
Start date: February 1996
End date: March 1999

Benefits

This project will provide the tools necessary to provide analog and mixed signal known good die to the industry.

Resources

Project Engineer: **Bill Russell**
WL/MTII
(937) 255-7371

Contractor: Rutgers State University

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Virtual Design Workspace for Collaborative Design Exploration

Contract Number: F33615-96-C-5607 ALOG Number: 1454

Statement of Need

During the last several years, design collaboration tools have been created or modified to work in an Internet or Intranet environment. The development of these tools, such as electronic whiteboards, electronic design notebooks, network based-video, e-mail archives etc., have been stand alone developments and have not been developed as an integrated design environment. The focus of this project is to consolidate these tools into an intuitive graphic and Icon-driven intuitive interface to allow distributed design group team members to interact with each other.

Approach

The contractor will utilize state-of-the-market distributed design tools and integrate them in a distributed collaborative environment with a homogeneous interface. The interface will use a design room graphic, which will have icon representations like a bookshelf for access to electronic parts catalogs and design notebooks. A chalkboard graphic will indicate shared whiteboard capability. A virtual meeting room, where a live video or a still picture of the person speaking will be posted, depending upon available network bandwidth. This approach will encourage designers to relate electronic capabilities to real world equivalents for ease of use in this distributed environment.

Status

Active
Start date: March 1996
End date: January 1999

Benefits

The benefits of this project will be to validate the effectiveness of an electronic virtual design environment for collaboration among geographically distributed design team members. The project will also prototype a graphic based interface to this electronic design environment.

Resources

Project Engineer: **Brian Stucke**
WL/MTII
(937) 255-7371

Contractor: Verifone/EIT

JDL Subpanel: Manufacturing and Engineering Systems

DARPA funded project under the Manufacturing Automation and Design Engineering Program (MADE)

Mixed Signal Test (MiST)

Cooperative Agreement Number: F33615-95-2-5562 ALOG Number: 1346

Statement of Need

The availability of sub-micron CMOS technology, precision bipolar capability and multichip modules (MCMs) continues to increase the complexity of analog and mixed-signal designs. Along with this increase in density and complexity come several challenges in developing test programs and test fixtures for mixed-signal modules in all stages of prototyping, production, and trouble shooting. The first challenge relates to complexity, density, lack of access to constituent ICs, and the need for interconnect testing. The second, has to do with the specification-driven nature of test procedures for mixed-signal circuits which poses two major problems. First is that in under-specified systems specification testing results in test programs with insufficient analog fault coverage for high quality products. Second is the inability to diagnose an out-of-specification system due to a lack of connection between specifications and component failures. Finally, there is the challenge of having to synchronize digital and analog test resources to test a mixed-signal circuit.

Approach

In this program, we propose to solve the above problems by expanding the capability of the IMS MCM Test Development System (TDS) to incorporate specification testing in the design hierarchy and relating it to the underlaying analog fault models. Mixed-signal scan and multiplexing techniques will also be introduced into the design-for-test process to enhance accessibility. The development and demonstration of controllability and observability test structures for analog devices will also be accomplished.

Benefits

The availability of test development tools and technologies integrated with mixed signal design environments will significantly decrease the test development efforts associated with production and support.

Status

Active
Start date: September 1995
End date: September 1998

Resources

Project Engineer: **Bill Russell**
WL/MTII
(937) 255-7371

Contractor: Boeing Company

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Behavior Analog Fault Simulation

Grant Number: F33615-96-1-5603 ALOG Number: 1422

Statement of Need

Analog and mixed signal testing follow different test methodologies from digital testing and are bottlenecks that not only lead to high testing costs, but also cause significant 'time-to-market' delays. Testing of mixed signal modules is also exacerbated by the high chip density and small interconnect line dimensions of new multi-chip modules (MCM). Many of the conventional approaches used for testing printed circuit boards are not applicable to dense MCM testing (i.e. bed-of-nails testing techniques).

Approach

The focus of this program is to use behavioral modeling for both good circuits and faulty circuits, based on a mixed signal hardware description language, VHDL-A. By exploiting the understanding gained recently in such areas as experimental design, control theory, system identification and applying the latest optimization techniques developed in mathematical optimization, new test algorithms can be developed. Hard-to-detect faults will be identified early in the design phase, which will facilitate design-for-test. New methods will be demonstrated through computer-aided design (CAD) and simulation software tool development.

Status

Active
Start date: December 1995
End date: February 1999

Benefits

This program will develop a new design methodology that will cut both cost and time spent on mixed signal testing. The goal is to provide more automated test generation during the design phase which will integrate analog and digital testing. The key to this goal is to use fault-driven testing for both analog and digital testing. By isolating difficult to test faults, design-for-test can be used more effectively. This technique also applies to advanced fault detection and fault isolation which maintains mixed signal module manufacturing processes.

Resources

Project Engineer: **Bill Russell**
WL/MTII
(937) 255-7371

Contractor: University of Iowa

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Laser-Based Reverse Engineering & Concurrent Systems

Contract Number: F33615-96-C-5616 ALOG Number: 1453

Statement of Need

The Department of Defense fleet of aircraft has an average age of 25 years. Structural parts of these aircraft are in constant need of repair or replacement. The current practice involves several months, with a Computer Aided Design (CAD) expert, measuring the original part and creating a three-dimensional CAD model of it so that the replacement part can be machined. This process can be very time consuming and take the aircraft out of service for an extended period of time. DoD needs a faster turn around on the manufacturing of these parts so that the aircraft returns to service as soon as possible. Engineers from the Wright Laboratory Manufacturing Technology Directorate are working with the Florida International University on a program which will try to develop a process in which laser scanners are used to reverse engineer the structural parts into CAD models which are then integrated with an existing concurrent engineering system to remanufacture these parts.

Approach

The Laser-Based Reverse Engineering and Concurrent Systems project will generate three-dimensional CAD models of scanned structural parts. Engineers will then determine the error ratio between the scanned CAD model and the original drawings (if available), correct the errors found, then generate the Numeric Code (NC) needed for the automated machining of these parts.

This program hopes to demonstrate the use of laser scanners to speed the process. By scanning these aircraft parts, in just days rather than months, the three-dimensional CAD models could be complete and the part could be machined in a shortened time span. This program will attempt to prove that the use of laser scanners will help speed the process, will address a requirement for the different departments of DoD, and will also provide direction for the commercial industries.

The project is part of the historically black college and university (HBCU) and minority institutions (MI) effort. This provision of the United States Code has a goal for each of fiscal years 1987 through 2000 to award five percent of contract and subcontract dollars to small disadvantaged business concerns and HBCU/MIs and requires a separate goal, for each of fiscal years 1991 through 2000 as a subset of the five percent goal, for the participation of HBCUs and MIs.

Benefits

A fully integrated reverse engineering and concurrent engineering system will provide the Air Force Logistics Centers with an efficient method for manufacturing critical components.

Resources

Project Engineer: **David Slicer**
WL/MTII
(937) 255-7371

Contractor: Florida International University

JDL Subpanel: Manufacturing and Engineering Systems

Status

Active
Start date: February 1996
End date: July 1998

Create a Process Analysis Toolkit for Affordability Supporting the R&D Process

Contract Number: F33615-96-C-5102 ALOG Number: 1441
Technical Report Number: In progress

Statement of Need

One of the hurdles in applying Integrated Product/Process Development (IPPD) to new technology is quantifying the transition cost and risk impact of critical design or architecture decisions. Determining how risk can be quantified for new technologies, how to base design decisions on process capabilities that aren't fully defined, and how to achieve in software the results being realized in electronics manufacturing, are questions which need to be answered.

Approach

An approach has been defined for quantifying the relative value of new designs in the context of business, product development and life-cycle processes. Based on a Value Analysis Scorecard, this methodology uses six sigma principles to directly compare design performance capability, part/supplier capability, process capability, supportability, life cycle cost and risk in an integrated matrix. The focus of the Process Analysis Toolkit for Affordability (PATA) is the Value Analysis Scorecard.

Status

Complete
Start date: February 1996
End date: September 1996

Benefits

The Value Analysis Scorecard is a powerful approach to estimating the relative value, costs and risks of new technologies during their development. It is believed that the scorecard technique can be used in any phase of a product's life cycle development. PATA is intended to be used by the science and technology community including industry, academe, and government, ensuring that research and development projects have viable, usable and affordable results.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: James Gregory Associates

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Internal Real-Time Distributed Object Management System

Contract Number: F33615-95-C-5537 ALOG Number: 1430
Technical Report: WL-TR-96-8009

Statement of Need

The manufacturing information systems environment consists of many types of computing devices, including "legacy" systems networked together. Data processing in such a heterogeneous environment is cumbersome and time consuming. When users of the system require data from the network, they spend considerable time searching for the needed data, and even when they find them, it is often difficult to obtain the data in proper electronic form. The objective of this Phase I Small Business Innovation Research (SBIR) project was to develop and demonstrate a completely internal, memory stored and executed, real-time distributed object management transaction system (IR-DOMS). This product will facilitate "transparent," "seamless" and "intelligent" data and information processing by human users on corporate-wide information system networks.

Approach

This effort's approach:
1) Provided the project technical plan of action, schedule and funding profile.
2) Identified requirements and developed required technical extensions to support a logical IR-DOMS system prototype.
3) Developed the software and assembled the equipment for the IR-DOMS prototype.
4) Developed the process scenario to exercise and measure the performance of IR-DOMS.
5) Integrated and tested the IR-DOMS prototype and pursued corporate sponsorship participation during the IR-DOMS development process.
6) Demonstrated the IR-DOMS prototype to an Industry Review board.

Status

Complete
Start date: April 1995
End date: November 1995

Benefits

Dual use was an integral part of this project. This technology applies to the information infrastructure technologies in financial, legal, or manufacturing. Successful marketing is already underway. Systran is doing product upgrades of international ScramNet installed customers of enhancements developed, tested and packaged during Phase I. The IR-DOMS technology can be used by any manufacturer to support the production of products for virtually any market including the process industries, automobile, petroleum, medical, aerospace, home and business appliances, electronics, and utilities.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Systran Corporation

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Internal Real-Time Distributed Object Management System

Contract Number: F33615-96-C-5112 ALOG Number: 1442

Statement of Need

Data processing in the heterogeneous manufacturing information systems environment is cumbersome and time consuming. When users of the system require data from the network, they spend considerable time searching for the needed data, and even when they find them, it is often difficult to obtain the data in proper electronic form. The objective of this Phase II Small Business Innovation Research (SBIR) project is to establish a real-time communications service internal to CORBA2 services supporting the application user and externally among user sites. This Internal Real-Time Distributed Object Management System (IR-DOMS) must resolve heterogeneous platform issues and provide the end user seamless, reliable capability to perform their job.

Approach

The approach will develop a commercial project, ORB-IT, during the enhancing and extending of functionality established in the demonstrated prototype of Phase I. Phase II will use and enhance the real-time architecture established in IR-DOMS Phase I; each computing node is a client and also a server available over standard fiber channel based gig-bit and conventional networks. Object Management Group's (OMG) ISO Standards will be used. The Object Request Broker (ORB) will support user applications and the Common Object Services Specifications (COSS) functions will provide capabilities required by the ORBs across different computers. A Technical Review Board (TRB) and multiple beta implementation sites will be established for IR-DOMS validation during the project. These sites will demonstrate commercial components products and systems in their production facilities by end of contract.

Status

Active
Start date: March 1996
End date: September 1997

Benefits

Under Phase I, 155 megabit bandwidths were successfully tested across multiple platforms using CORBA, the OMG standard. In Phase II, ORB-IT technology performing at gigabit bandwidths is being inserted in specialty products. The ORB-IT technology is being transitioned as FiberExpress™ and will become a standard line. The IR-DOMS technology can be used in any information systems environment and by any manufacturer to support the production of products for virtually any market including the process industries, automobile, petroleum, medical, aerospace, home and business appliances, electronics, and utilities.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Systran Corporation

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Product Data Netshape Forming Machine

Contract Number: F33615-95-C-5536 ALOG Number: 1432
Technical Report: WL-TR-96-8012

Statement of Need

Structurally significant alloys have usually consisted of titanium, steel and wrought light-weight alloy systems. A market requirement for light-weight alloy components and their various composite types now exists. The objective of this Phase I Small Business Innovation Research (SBIR) program was to identify and analyze the requirements of a Netshape Forming Machine system.

Approach

A feasibility study was conducted to show the potential for commercializing a Product Data Netshape Forming Machine System. This system was to make Netshape parts having mechanical properties equivalent to forged parts. Universal Energy Systems Incorporated developed the technology into a product called the KI Shell. The KI Shell is an object-oriented productivity tool for prototyping and developing software that supports the carrying out of activities needed to form a full process. The KI Shell creates a cohesive and rapid response to any one of a manufacturer's numerous dilemmas by integrating the hardware and software systems that are vital but often isolated and limited. The result is a streamlined process and high productivity and quality with reductions in production time.

Status

Complete
Start date: April 1995
End date: November 1995

Benefits

The technology developed in this program can be used by any manufacturer to produce products for use in virtually any marketplace where the manufactured products are piece parts or end item entities made of flat materials or injection molded materials. KI Shell continues to set the pace as the only generic, standards-based and 100 percent open product capable of operating as an independent enterprise infrastructure workflow engine. The KI Shell has been commercialized and is currently in use at over 25 different companies including IBM, GM, Douglas Aircraft Company, and EDS.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Universal Energy Systems Incorporated

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

ModelQuest Software Process Quality Assessment

Contract Number: F33615-95-C-5544 ALOG Number: 1419

Statement of Need

Statistical network modeling technology will enable the Department of Defense and industry to automatically generate powerful models of software, product, and/or process quality that are tailored to specific organizations based on their historical metrics and defect data. Computer software programs, such as the one used in the Large Aircraft Robotic Paint Stripper, must be reliable and free of defects, to avoid costly, life-threatening errors. AbTech Corporation is developing a superior ModelQuest (MQ) Metrics product which automatically produces expert evaluations of software quality and generates tailor-made computer models.

Approach

AbTech's MQ will be used as the baseline tool set for the project and will be integrated with a mix of other advanced computing technologies to form the hybrid environment needed to develop a superior assessment model. The models use mathematical functions and the self-learning properties of neural networks to predict software errors. The models are powerful feed-forward networks of mathematical functions and a single network can use several different types of functional nodes. MQ Metrics analyzes software source codes, produces statistics and metrics and provides measures of what these mean, produces exceptionally accurate reliability and maintainability predictions, assesses source code quality, identifies significant variables and generates reports and graphs. Some of these reports will identify the quality of each module as well as the key factors impacting the probability of a given module having significant defects. This predictive capability will enhance software quality control, improve efficiency, and optimize resources. MQ Metrics includes source code metrics generation, reliability prediction and maintainability evaluation software. MQ Expert will be an intelligent system development tool which integrates MQ and database management, visual analysis, report generation, and expert system software, to enable users to obtain a variety of reports and visual information with which they can analyze their software quality and development process.

Status

Active
Start date: October 1995
End date: July 1997

Benefits

This model eliminates the need for users to be very knowledgeable about software quality control techniques. These products have a tremendous potential for technology transfer, as they can be used by any company and anyone responsible for managing, designing, developing, testing, maintaining and inspecting software.

The tool will be used in testing software with embedded coding used in the Large Aircraft Robotic Paint Stripper (LARPS) at the Oklahoma City Air Logistics Center. The resulting predictive capability provided by this tool has created an additional market of 3,500-4,000 customers for this product.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Abtech Corporation

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Integrated Knowledge Environment - Integrated Product Management

(Manufacturing Integration/Infrastructure Technologies)

Contract Number: F33615-96-C-5556 ALOG Number: 1438
Technical Report Number: In progress

Statement of Need

There is a need for innovative acquisition tailoring and alternative development processes for program management tools. Users need reference libraries that contain standards, handbooks, templates, guidelines, etc., which are accessible over local and wide area networks. There is also a need for tools that automatically produce tailored project plans and schedules from process model templates which contain systems engineering/configuration management activities for the various engineering and manufacturing disciplines. This effort demonstrated the concept of an Integrated Knowledge Environment (IKE) Integrated Product Management (IPM) framework which provides a process oriented environment with encapsulated tools, methods and techniques that enable affordable analysis. The IKE provides a variety of capabilities which allow the user to graphically develop a process model. It also provides a forms manipulation tool that enables the user to graphically create, edit and fill-in electronic business forms and map data to and from local or remote databases.

Approach

The IKE-IPM framework was jointly developed under a Small Business Innovation Research contract by Knowledge Base Engineering, Inc., and Oklahoma State University. The IKE environment encapsulates a second environment and creates the necessary environment for software. The encapsulated second environment is the IPM. The IKE-IPM environment integrates program management functionality, process and information templates, configuration item work breakdown structures, cost/risk analysis, decision support, affordability analysis, and Microsoft Office tools into a seamless Integrated Product Management framework. The IKE-IPM is designed to support the R&D Integrated Product and Process model, and the five life cycle phases of the 499B Systems Engineering/Configuration Management process model.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Knowledge Base Engineering Inc.

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Benefits

Under Phase I, this technology was inserted into three successful Air Force pilots, being used in environmental, sustainment and project management applications. The IKE provides a variety of capabilities that enable the user to graphically develop a process model. For example, the user can launch any analysis tool, word processor, spreadsheet or CAD software directly from a process model. IKE also provides a forms manipulation tool that enables the user to graphically create, edit and fill-in electronic business forms and map the data to and from local or remote databases. This project analyzed standard life cycle models; established a standard compliant Affordability Framework; established a standard compliant LC phase and transition architectures; developed the IKE-IPM prototype; and performed a state-of-the-art affordability tools survey.

Status

Complete
Start date: September 1995
End date: May 1996

Integrated Design and Solidification Modeling

(Manufacturing Integration/Infrastructure Technologies)

Contract Number: F33615-96-C-5547 ALOG Number: 1440
Technical Report Number: In progress

Statement of Need

Under this Phase I Small Business Innovation Research (SBIR) project, Metal Matrix Cast Composites, Inc. (MMCC) developed a process to integrate design and solidification modeling into a near-absolute net-shape casting production machine. This research is novel in that components begin as CAD solids models and are sent via a communications link to Oak Ridge National Laboratory for FEA and solidification analysis. The data is then sent back to MMCC to a CNC for mold creation and finally cast to near-absolute net-shape at MMCC. The changes in process and using the ISO-STEP standards is a first step in the integration of mechanical processes, materials and computer technology standards. This will enable a move towards the technology shift in manufacturing required to advance the state of the art and move manufacturing in the direction of a major paradigm shift.

Approach

MMCC, Inc. has demonstrated that near-absolute net-shape parts can be made at low cost using their Advanced Pressure Infiltration Casting (APIC™) technology. Aluminum alloys, steel, copper and superalloys have all been cast with reinforcements yielding outstanding strength and stiffness values. With assistance from Oak Ridge National Laboratories, they incorporated CAD/CAM/CAE tools and customized solidification software into APIC. Rapidly prototyped castings that hold extremely tight tolerance with zero shrinkage will meet the designers' intent needing little compensation normally associated with traditional casting processes. Phase I development included analyzing and modeling solidification from data taken in real time. MMCC integrated their computer system to ISO-STEP standards to provide universal acceptance of industry wide data to their system. A demonstration component that includes net-shape tapers, threads, and holes was manufactured. This demonstration component began as a CAD solid model and was sent to Oak Ridge national Lab for FEA and solidification analysis. The file was sent back to MMCC, sent to a CNC to create molds, and then cast near-absolute net-shape at MMCC. This component was a bicycle crank which was designed and developed for an olympic racing team. The cycle from the time the customer established the requirement to the time the product was delivered was reduced from 120 days to five days, while increasing the part strength by 300 percent and reducing its original 26-ounce weight by 10 ounces.

Status

Complete
Start date: September 1995
End date: May 1996

Benefits

The Air Force will benefit from having available new technology that can decrease the delivery time for parts to the point of need in the field. This work will lead to reductions in cost of producing both simple and complex formed products. MMCC is involved in prototyping aircraft brake parts and licensing APIC technology to the automotive industry and heavy equipment manufacturers. Greater integration will make the process more flexible and prototyping will be more rapid and more representative of true large-scale manufacturing. Applications include automotive, aerospace, marine, and sporting goods. These applications all require high performance materials at low cost. The Defense Advanced Research Projects Agency and the Navy have awarded a contract to develop this technology as an on-board part production facility. The Manufacturing Technology Directorate will participate in this and is studying Air Force impact of this technology and its applications for small parts production.

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: Metal Matrix Cast Components Inc.

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Helioimaging Durable Product Generator

(Manufacturing Integration/Infrastructure Technologies)

Contract Number: F33615-95-C-5557 ALOG Number: 1439
Technical Report Number: In progress

Statement of Need

Efficient and effective visualization of spatial information is vital in such widely disparate fields as manufacturing, defense, training, medical, commercial and entertainment. A multi-dimensional situational awareness display can integrate terrain, environment, target and threat data into an easily visualized representation of the battlefield, enabling rapid formulation of sound tactical decisions. Similarly, the design and development of new industrial products could be facilitated using a high-quality, multi-dimensional imaging system in conjunction with computer-aided design software packages. Multi-dimensional display of medical images promises more accurate diagnoses, safer surgical procedures and potentially lower medical costs. In addition, multi-dimensional air traffic control systems may significantly lessen collision risks at high-volume airports.

Many multi-dimensional technologies have been proposed, developed and tested over the past decades, but none has achieved the acceptance enjoyed by two-D display technologies. Two major recurring problem areas have been the requirement for a viewer-worn apparatus (glasses, goggles), and the presence of scene distortions inherent in fixed, two-view stereo systems. This approach solves both problems because it's autostereoscopic (no eyeware is required) and multiperspective (all views necessary for full horizontal parallax are presented).

Approach

American Propylaea Corporation has developed an HG-ALPHA Simulator Display Workstation which produces holographic images to be used in virtual prototyping. The images are easily manipulated and have potential applications in manufacturing, defense, training, medicine and entertainment. GM, Ford and Chrysler are now actively involved in developing this technology for its potential use in automobile production. Propylaea's scientists have developed techniques which address long-standing limitations in the field of holography. In this Phase I Small Business Innovation Research (SBIR) project, a prototype was demonstrated to several hundred engineers, scientists, product designers and management at the Society of Automotive Engineers International Congress and Exposition. The multi-dimensional holography-assisted display is based on the Propylaea corporation-licensed design concept which uses high-performance, multi-pupil holographic lenses. The contractor demonstrated a three-viewpoint, stereo accurate, full-color, live, no glasses, 55-inch display to aid design engineers — primarily in the automobile industry, where designs are sales-critical and slow to affect with current technology.

Benefits

The initial applications are real-time, three-dimensional holographic displays for the computer-assisted manufacturing and design segment of the defense, automotive design, engineering, and manufacturing environment. Each computer-assisted design and manufacturing workstation requires a display monitor to view the images being created or engineered.

The company's technology will satisfy the most critical need in Air Force or commercial manufacturing: to reduce model development time while maintaining quality requirements. This display system may reduce the time required to take a new vehicle from the concept stage to the showroom from the current 42 months, to 20 months or less. Another major market is in medical display systems, where the HG ALPHA system may have military applications, such as to aid in detecting and locating abnormalities, reduce the need for exploratory operations and assist in training of surgeons for battlefield surgery.

The HG-ALPHA display system may eliminate physical models (clay, wood, etc.), enable networking internally and with component suppliers, accelerate executive decision making, reduce errors in going from modeled surfaces to tooling, and reduce operating costs.

Status

Complete
Start date: September 1995
End date: March 1996

Resources

Project Engineer: **David Judson**
WL/MTI
(937) 255-7371

Contractor: American Propylaea Corp.

JDL Subpanel: Manufacturing and Engineering Systems

SBIR Funded

Development of Adaptive Modeling Language for Knowledge-Based Systems

Contract Number: F33615-96-C-5606 ALOG Number: 1476

Statement of Need

The overall objective of the Manufacturing Automation and Design Engineering (MADE) program is to develop engineering tools and information integration capabilities that could be used to evaluate an order of magnitude more design alternatives than is possible today in an attempt to optimized several product characteristics, and quickly prototype complex products and processes.

Approach

The contractor will develop an application to the Adaptive Modeling Language (AML) for knowledge-based engineering with the ability for application to all Department of Defense and commercial electro-mechanical systems. AML will be applied to the specified multidisciplinary design of gimbal systems, capturing knowledge to streamline the gimbal design process but allowing a software structure that permits creativity while simultaneously capturing the knowledge of the creativity.

Status

Active
Start date: March 1996
End date: May 1998

Benefits

This effort will develop an adaptive modeling language for domain-specific, knowledge-based engineering in the electro-mechanical design process. The resulting integrated CAD tools and methods including process knowledge will reduce product development cycle, increase design reuse and capture design functionality. The end system will be supported by commercial CAD tools that will have the capability of being applied to DoD and commercial electro-mechanical systems.

Resources

Project Engineer: **Alan Winn**
WL/MTIM
(937) 255-7371

Contractor: Lockheed Martin Corp.

JDL Subpanel: Manufacturing and Engineering Systems

DARPA Funded

Completed Projects

Cell for Integrated Manufacturing Protocols, Architectures, and Logistics

(Page 73) Contract Number: F33615-90-C-5003 ALOG Number: 89
Technical Report Number: In progress

This project established an integrated flexible manufacturing cell for use as a laboratory for students, faculty, and small aerospace manufacturers. It is employed as a demonstration site for networking and other technologies. The project was completed in December 1995. **JDL Subpanel:** Metals

POC: David See
WL/MTPM
(937) 255-3612

General Purpose Noise Cancellation Processor

(Page 79) Contract Number: F33615-94-C-4403 ALOG Number: 612
Technical Report Number: In progress

Project end date has been extended to December 1996. **JDL Subpanel:** Metals

POC: Deborah Kennedy
WL/MTPM
(937) 255-3612

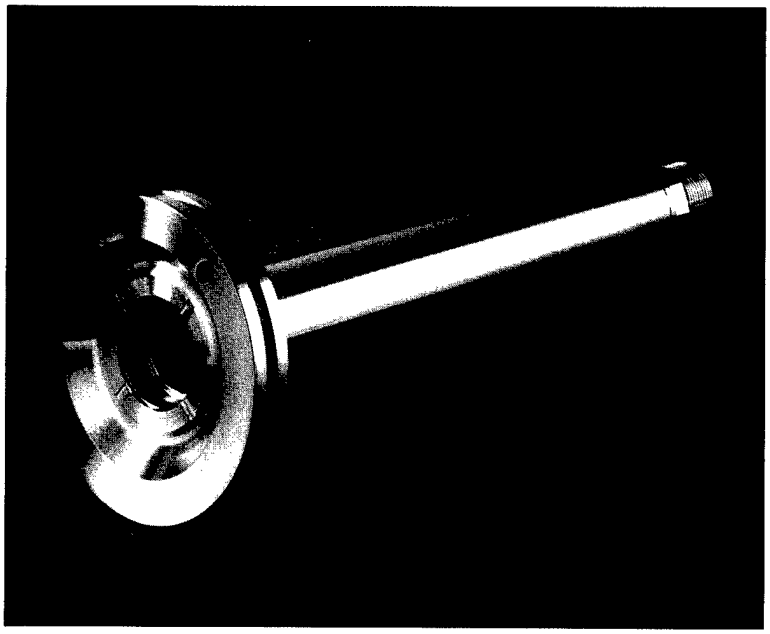
Metals

Titanium Matrix Composite Actuator Piston Rods

(Page 87) Contract Number: F33615-91-C-5731 ALOG Number: 639
Technical Report: In progress

This effort defined a cost-effective manufacturing process for the fabrication of the exhaust nozzle actuator piston rod for the F119 turbine engine. The program was completed in September 1996. **JDL Subpanel:** Metals

POC: Siamack Mazdiyasni
WL/MTPM
(937) 255-2413



Active Projects

Advanced Reconfigurable Machine for Flexible Fabrication

(Page 72) Contract Number: F33615-95-C-5500 ALOG Number: 1352

Update - After some initial concept work, Ingersoll has determined that it is feasible to mount position accuracy lasers onto a conventional, thermally stable Invar insert in the upper outer hexapod struts. This will permit the lasers to detect the thermal growth in the entire length of the strut. Because of this, it is not necessary to make the upper outer tube out of near zero CTE composite components. The design of the thermal control system for the horizontal octahedron frame has begun. Currently, fluid passages and the pumping system required to provide the thermal control are being designed. **JDL Subpanel:** Metals

POC: Timothy Swigart
WL/MTPM
(937) 255-3612

Development of a New Precision Magnetic Spindle Technology

(Page 74) Contract Number: SPO900-94-C-0007 ALOG Number: 1229

Update - Project end date has been extended to December 1996. **JDL Subpanel:** Metals

POC: Deborah Kennedy
WL/MTPM
(937) 255-3612

Engine Supplier Base Initiative

(Page 75) Cooperative Agreement Number: F33615-95-2-5555 ALOG Number: 1265

Update - The program management team has evaluated four projects submitted by the BP&P team for approval. The projects are: Simplified Audit Procedures; Common NDT Specifications; Process Change Approval Procedure; Common Testing Specifications. The next step is to establish working teams, develop schedule and work plan, implement and test BP change, and then evaluate against the expected metrics. **JDL Subpanel:** Metals

POC: Siamack Mazdiyasni
WL/MTPM
(937) 255-2413

Flexible Fabrication with Superconducting Magnetic Clamps

(Page 77) Cooperative Agreement Number: F33615-95-2-5540 ALOG Number: 1379

Update - The magnet design has been finalized, and has been implemented in a pre-prototype clamp build by IGC. Finite element modeling has confirmed that the design should provide a clamping force consistent with the design requirement of 50 psi. Pulse charging experiments have also been favorable, and confirm that a coil of the appropriate size can produce the magnetic fields sufficient to charge the clamp. The cost model, when applied to the wing skin tooling for the F-22 program, indicates cost reductions on the order of 50 percent. All activities are on schedule and within budget. This project is currently scheduled to end at the end of Phase I. **JDL Subpanel:** Metals

POC: Kevin Spitzer
WL/MTPM
(937) 255-2413

Flexible Laser Automated Intelligent Research System for Manufacturing and Fabrication

(Page 78) Contract Number: F33615-95-C-5503 ALOG Number: 1354

Update - Program review held. **JDL Subpanel**: Metals

POC: Rafael Reed
WL/MTPM
(937) 255-2413

Active Projects

Laser Forming for Flexible Fabrication

(Page 80) Contract Number: F33615-95-C-5542 ALOG Number: 1369

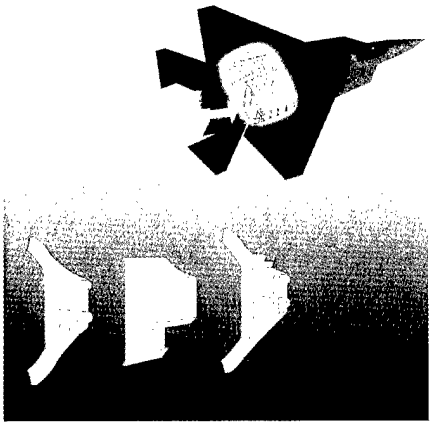
Update - Flexible Fabrication Interchange meeting held in Alexandria, VA. **JDL Subpanel**: Metals

POC: Rafael Reed
WL/MTPM
(937) 255-2413

Manufacturing Technology for Welded Titanium Aircraft Structures

(Page 81) Contract Number: F33615-93-C-4302 ALOG Number: 713

Update - The Manufacturing Technology for Welded Titanium Aircraft Structures program developed, demonstrated, and implemented producibility improvements in the manufacturing processes required to affordably produce large, complex, high quality, welded titanium fighter airframe assemblies. The developed processes also improve structural reliability and reduce weight in the assembled structure. The cost drivers associated with the fabrication of the welded titanium structure of the F-22 aft fuselage forward booms were identified to be the ancillary processes associated with the welding process and not the electron beam welding process itself. Process improvements including: localized weld repair, localized stress relief, localized cleaning methods, laser weld finishing passes, automated inspection methods, witness line application tools, robotic weld bead shaving and revised electron beam welding schedules were developed to address each of the identified cost drivers. Each of the process improvements were demonstrated and validated demonstrated on a two bay section of the forward boom to demonstrate the production readiness and to facilitate the rapid implementation of the processes to the production floor. The localized weld repair, localized cleaning methods and witness line application tools have been incorporated into the processes being used to build the F-22 EMD vehicles. The program will be completed in January 1997. **JDL Subpanel**: Metals



POC: Kevin Spitzer
WL/MTPM
(937) 255-2413

Neural Network Error Compensation of Machine Tools

(Page 82) Contract Number: F33615-95-C-5541 ALOG Number: 1389

Update - Finished instrumenting the Z-Axis and the spindle with thermocouples and began implementation of compensation in the controller. Also began expanding kinematic model to include machine reversal motions. Installed and tested thermocouples on the Z-Axis around the spindle housing. Eliminated 10 thermocouples as input candidates from other areas of the machine to make room in the computer for these additional thermocouple inputs. Put together a simple kinetic preliminary geometric/thermal model. Successfully tested the kinematic model for forward motions in the machine and modified it to handle reversal motion. **JDL Subpanel:** Metals

POC: Siamack Mazdiyasni
WL/MTPM
(937) 255-2413

Precision High Speed Machining With Vibration Control

(Page 83) Contract Number: SPO900-94-C-0010 ALOG Number: 1261

Update - Finished identifying the machine tool requirements. **JDL Subpanel:** Metals

POC: Rafael Reed
WL/MTPM
(937) 255-2413

Active Projects

Precision Machining Program

(Page 84) Contract Number: F33615-94-C-4440 ALOG Number: 1271

Update - VTL Performance Tests carried out in June 1996 discovered cutting fluid seepage into the activator force plate area causing damage to two of the four PMN activation stacks. The two spare stacks, along with the two surviving stacks, were sent to G&L for new shims, and two new stacks were built as spares. In July, the PMN stacks and mechanical subsystem were successfully put together. The stack cavities were filled with mineral oil against contamination from the coolant fluid. Assembly of the subsystems did not seem to be too tedious and the preloading of the stacks was precise and repeatable. The VTL team will be working with the ABBS team to implement the adaptive FXLMS approach for the VTL project as an alternative controller. The ABBS2 system performed successfully at the factory floor demonstration held in September and is ready for transition. **JDL Subpanel:** Metals

POC: Timothy Swigart
WL/MTPM
(937) 255-3612

Titanium Matrix Composite Turbine Engine Component Consortium

(Page 88) Cooperative Agreement Number: F33615-94-2-4439 ALOG Number: 1286

Update - The Titanium Matrix Composite Turbine Engine Component Consortium (TMCTECC) Program is a cooperative arrangement between the government and key industrial participants to mature and deploy silicon carbide (SiC) reinforced component technology in advanced gas turbine engines. The program focuses on large engine component applications which require sufficient annual material volumes to stabilize the supplier industrial base. Such a stable industrial base can readily meet military needs for this key propulsion material at an affordable cost. Further, the ready availability of TMCs will speed their implementation in a variety of performance-enhancing applications in the engines and airframes of our most advanced military aircraft.

The TMCTECC has completed the first phase of a multi-phased effort which will span five years. In Phase I, it was demonstrated that a common raw material form would serve in both fan frames and fan blades. It was also shown that this material form could be delivered for $500 per pound in quantities of 15,000 pounds per year or greater. Full scale GE90- and PW 4084-sized experimental components were fabricated.

Phase II is currently underway and is Defense Production Act Title III funded. This phase is focused on establishing a production capacity and the cost/benefits trade-offs associated with the use of TMC-enhanced components in both military and commercial engines. The program is focused on cost reduction since it is believed that the cost of TMC-enhanced components has precluded their use to date. Here the TMC-enhanced components must demonstrate significant performance incentives relative to metallic components to warrant their use in fleet engines. **JDL Subpanel:** Metals

POC: Kevin Spitzer
WL/MTPM
(937) 255-2413

Ultra-Thin Cast Nickel-Base Alloy Structures

(Page 89) Contract Number: F33615-93-C-4305 ALOG Number: 710

Update - The program is being re-directed to investigate the application of ultra-thin wall casting technology to the turbine exhaust case (TEC). Specifically, a program plan is being evaluated to develop the casting process and produce development hardware for the TEC ID and OD panels and vane. The goal is to develop the cast ID panel for ISR qualification and the OD panel and vane for OCR qualification. These components will be qualified in the F119 engine. **JDL Subpanel:** Metals

POC: Rafael Reed
WL/MTPM
(937) 255-2413

Advanced Six-Degree-of-Freedom (6-D) Laser Measurement System

Contract Number: F33615-95-C-5549 ALOG Number: 1443
Technical Report Number: WL-TR-96-8016

Statement of Need

In order to remain competitive in today's global marketplace, U.S. manufacturers are constantly striving to hold tighter and tighter tolerances on the parts they produce. What this means is that the manufacturer needs to better control the machines they use to produce these parts, and in order to do that, they need an instrument that can quickly and easily characterize the geometric properties of the machines being used.

Approach

Several versions of the roll detector had been built and methodologically studied. The study led to new and crucial findings about the physical phenomena governing the proposed design. These findings will be extremely valuable in the design of an improved roll detector and subsequently a pre-production 6-D laser measuring system anticipated in Phase II.

Technical activity is complete. The final report (Advanced Six-Degree-of-Freedom (6-D) Laser Measurement System, WL-TR-96-8016, February 1996) has been submitted. The achievements and findings in this Phase I work have been successful. The work was completed within budget and on time. The laser roll detector concept has been successfully demonstrated. Although the intense study of the long-term drift had prevented the contractor from integrating the detector to the 5-D laser as originally planned; nevertheless, the subsequent knowledge gained is tremendous.

Benefits

The study led to (i) a much better understanding of the physics of all the electro-optical components, (ii) an improved roll detector design that can virtually eliminate any cross-talks from lateral, pitch and yaw movements, and (iii) a new and compact optical arrangement that can further increase the system sensitivity by four fold.

Resources

Project Engineer: **Rafael Reed**
WL/MTPM
(937) 255-2413

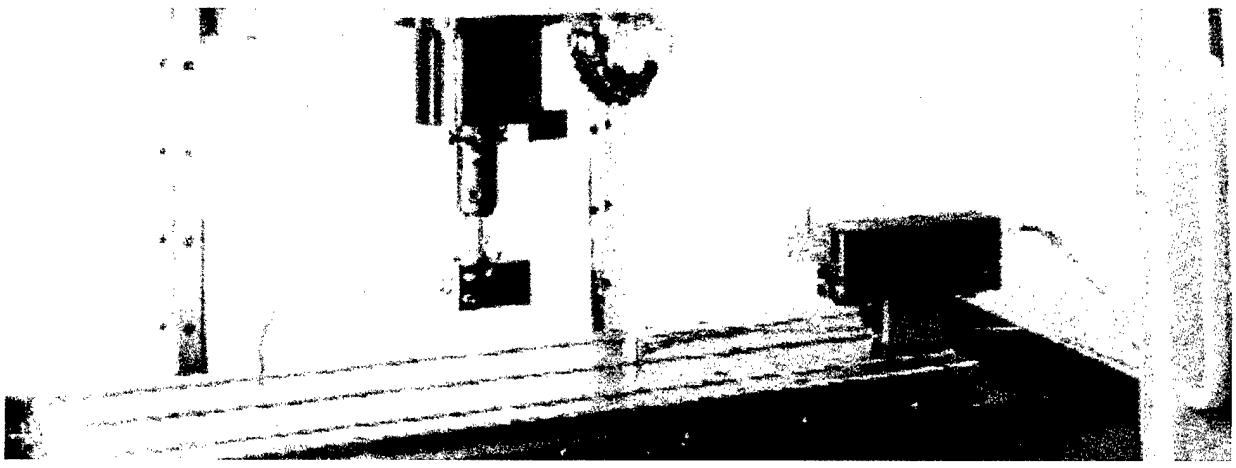
Contractor: Automated Precision Incorporated

JDL Subpanel: Metals

SBIR Funded

Status

Complete
Start date: July 1995
End date: January 1996



Advanced Six-Degree-of-Freedom Laser Measurement System

Contract Number: F33615-96-C-5106 ALOG Number: 1449

Statement of Need

In order to remain competitive in today's global marketplace, U.S. manufacturers are constantly striving to hold tighter and tighter tolerances on the parts they produce. What this means is that the manufacturer needs to better control the machines that they use to produce these parts, and in order to do that, they need an instrument that can quickly and easily characterize the geometric properties of the machines being used.

Approach

The approach will be to build and test an improved roll detector based on lessons learned from the Phase I effort. The contractor will also determine and confirm the operability and stability of the final design. The contractor will fully integrate the roll detector into an existing five-degree-of-freedom laser measurement system as a pre-production unit. Testing of the pre-production unit will be made to confirm adequacy of performance and evaluate short and long-term stability

Status

Active
Start date: July 1996
End date: July 1998

Benefits

The multiple degree of freedom measurement system has the potential for application in any industry area that uses a coordinate measuring machine (CMM) - virtually every manufacturer in the world. This product could be a valuable tool for teaching factories and manufacturing extension centers as well.

Resources

Project Engineer: **Rafael Reed**
WL/MTPM
(937) 255-2413

Contractor: Automated Precision Incorporated

JDL Subpanel: Metals

SBIR Funded

Flexible Fixturing System

Contract Number: F33615-95-C-5554 **ALOG Number: 1425**
Technical Report Number: In progress

Statement of Need

The Intelligent Machining Workstation (IMW) program, U.S. Air Force Wright Laboratory Manufacturing Technology Directorate contract F3315-86-C-5038, developed a prototype set of software modules and novel tooling designed to perform unattended metal cutting planning and execution. The results showed use of this system resulted in a more efficient operation. This modular system can be used in total, or tailored to fit the needs of any size manufacturer. The development work accomplished resulted in a prototype system demonstration at Cincinnati Milacron, the prime contractor. No commercial activity was ever pursued after contract completion. The major cause of the high cost in the planning stage is the need for a skillful designer/operator and the long time necessary for fixture design and allocation.

Currently, fixture design and allocation is mostly done through the experience and intuition of skillful machinists. This is especially true for custom-made special fixtures, which may take weeks to complete. Even when using modular fixtures, it may still take days for a skillful worker to allocate and set up the fixture. The major cause of high cost in the execution stage lies in the lack of dexterity of existing fixtures. In most cases, traditional fixtures, such as vises or toe clamps, only allow machining on one or two faces of a workpiece. To enable cutting on all six faces, the workpiece must be repetitively released from the fixture, or holding device, reoriented, and re-fixtured to reveal the desired face to the cutting tool. After each re-fixturing, the exact position of the workpiece must be regaged, and the tool position must be reset, before the next cutting step can start. When using modular fixtures or special fixtures, the problem still exists. In many cases, more than one fixture setup is required for a single workpiece in order to enable cutting on all six faces.

Metals

Approach

Two approaches were used to attack the problems of the fixturing process in this Phase I SBIR. First, a new Dual Dexterous Vise (DDV) system was designed and tested. The DDV system is capable of holding a workpiece and reveals all of its six faces to the machining tool, without the need of many steps of refixturing, regaging, and tool resetting, which is the major bottleneck in the machining process. Second, a computer software-based method for aiding and systematizing the procedure of fixture selection and allocation was developed.

Benefits

The intelligent flexible fixturing system can shorten fixture planning time, reduce setup time, and reduce the need for regaging and tool resetting.

Resources

Project Engineer: **Timothy Swigart**
WL/MTPM
(937) 255-3612

Contractor: Act Research Corporation

JDL Subpanel: Metals

SBIR Funded

Status

Complete
Start date: October 1995
End date: April 1996

Production Laser Peening Facility Development

Contract Number: F33615-96-C-5624 **ALOG Number: 1456**

Statement of Need

The lifetime of turbine engine airfoils is of major importance to the Air Force, commercial engine manufacturers, and commercial airlines. Foreign object damage (FOD) and high cycle fatigue are serious concerns since they can result in the destruction of the engine, loss of aircraft, and possibly loss of life. Several fatigue life enhancement techniques are currently in use on airfoils and other structures, most notably shot peening or glass bead peening. These techniques impart compressive residual stresses to a thin layer of the surface of the airfoil. If the compressive residual stresses can be driven deeper into the surface, the fatigue life enhancement would be even greater. This can be accomplished by using a high-energy laser pulse to generate shock waves on the surface, which is a process called laser peening. It provides an alternate fatigue life enhancement method that could possibly be used in cases where the use of another method is not possible.

Approach

The project is divided into three sequential phases. Phase I (17 tasks) is a six-month effort to resolve outstanding technical issues associated with the laser components, solidify the final design and develop final system specifications. Phase II (six tasks) is a ten-month effort focusing on acquisition, assembly and subsystem check-out. Phase III (four tasks) is a two-month effort for system check out and performance characterization.

Resources

Project Engineer: **Timothy Swigart**
WL/MTPM
(937) 255-3612

Contractor: LSP Technologies

JDL Subpanel: Metals

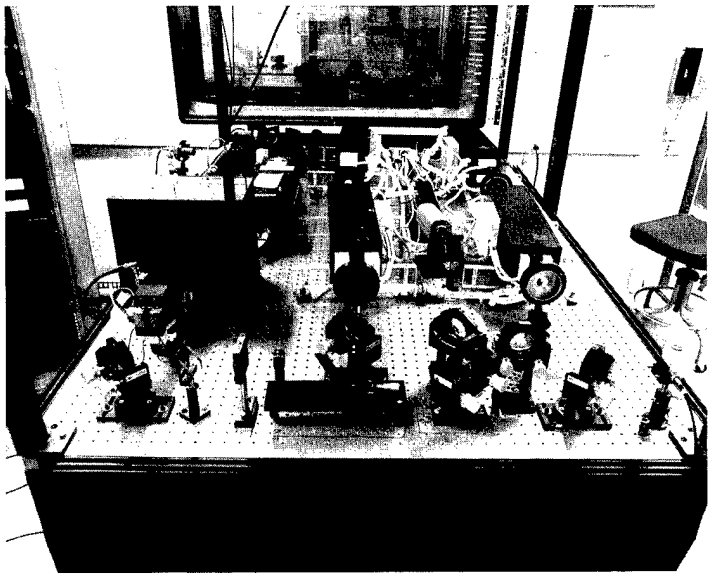
SBIR Funded

Benefits

All commercial engine manufacturers are bound by the same airfoil design constraints as the Air Force. Airfoil life is a limiting feature in all gas turbine engines, and improvements would create significant savings in blade life costs and flight safety. The technology developed under this topic would also have application to initiatives such as artificial joints. The objective of this Phase II SBIR is to extend the Phase I research to develop a state-of-the-art laser peening facility. It will be capable of meeting the near term production needs of the Air Force while providing a facility for the introduction of laser shock peening to other commercial markets. This effort will demonstrate the operation of an industrial grade, Class 1 laser system for laser shock processing and integrate it to an enclosed robotic work station to form a complete laser shock processing facility.

Status

Active
Start date: April 1996
End date: December 1997



High Speed Volumetric Metrology

Contract Number: F33615-95-C-5550 ALOG Number: 1393
Technical Report Number: In progress

Statement of Need

Coordinate Measuring Machines (CMMs) have become an integral part of the manufacturing process and are used in all stages of manufacturing. Calibration of these machines is critical to ensure that the desired degree of precision is achieved. Using optical tools such as laser interferometers, the Multiple Degree of Freedom Measurement (MDFM) system developed by the University of Michigan under the U.S. Air Force Manufacturing Technology program has demonstrated a high precision calibration capability for CMMs.

Approach

This program demonstrated a MDFM design with equivalent performance but with reduced complexity, a greater degree of robustness and flexibility, and with a reduced capital cost since the system will be built from inexpensive components. The overall design closely resembles the successful GPS, but instead of microwave beams it uses intensity modulated optical beams at high >5 GHz microwave frequencies to provide 3D positional information. A significant factor contributing to the lower cost is the availability of hardware and software technologies already developed for microwave and optical through-the-air and guided communications networks.

Resources

Project Engineer: **Deborah Kennedy**
WL/MTPM
(937) 255-3612

Contractor: Visidyne Incorporation

JDL Subpanel: Metals

SBIR Funded

Benefits

The measurement technique provided precise 3-D optical monitoring of positions in real time, with large dynamic range through the use of inexpensive, available components. Advantages of the technique include:

- The optical trilateration technique does not rely on accurately calibrated multi-axis translation mechanisms, but on simple optical ranging from fixed points on the metrology frame.
- Reduction in the number of geometric error components which must be measured and compensated for, thereby reducing error build-up.
- Inherently simple hardware implementation, with accompanying reliability and maintainability advantages.
- In contrast to interferometric techniques, the intensity modulated optical beams will be more immune to the effects of dust, momentary mechanical shock, and occasional beam interruption which would cause an interferometric system to lose fringe count.

Status

Complete
Start date: August 1995
End date: February 1996

Development of a Commercial Multiple Degree of Freedom Measurement System

Contract Number: F33615-95-C-5551 ALOG Number: 1390
Technical Report Number: In progress

Statement of Need

A significant commercial opportunity exists which capitalizes on a laser-based measurement system recently developed for the U.S. Air Force Manufacturing Technology Directorate. The device, a Multiple Degree of Freedom Measurement system (MDFM), demonstrates a technique for simultaneously measuring five geometric error components along a single machine axis. The MDFM system offers several key advantages over existing products in the machine tool industry. Compared to laser interferometer systems, the MDFM is much easier to set-up, is less environmentally sensitive, and most importantly, has the capability of operating while the machine tool is engaged in material removal operations. The MDFM provides an electronic signal easily incorporated into machine tool controls and automated data collection equipment, thereby offering the advantage of automation when compared to precision levels or dial indicators. The precision offered by the MDFM system as prototype in 1991 for the U.S. Air Force's Wright Laboratory is adequate for machine tool calibration purposes. However, precision can be enhanced, the work envelope can be enlarged, the number of components can be reduced and the system set-up time can be minimized while costs are reduced with the performance improvement measure being proposed. Additionally, a commercial version of the MDFM system will incorporate a rugged enclosure and many design-for-manufacture enhancements.

Approach

The MDFM has been improved to incorporate and demonstrate state-of-the-art technology, to prepare the device for factory floor service, to improve its ease of use, and to expand the versatility of its applications under this Phase I Small Business Innovation Research (SBIR) program. The Phase I activities included identification of MDFM applications and markets, improvement of the existing design to suit identified markets, construction of an alpha-version prototype, and analysis and revision of the alpha-version prototype design in preparation for Phase II beta-testing. Results indicate the alpha-version attained an acceptable accuracy (15 microns linear, 4 arcsec. angular), improved stability (2 micron drift over 50 hours), and reduced cost as compared to the previous model.

Technical activity is complete. The final report (Development of a Commercial Multiple Degree of Freedom Measurement System) has been submitted. The Multiple Degree of Freedom Measurement (MDFM) System, initially developed under Wright Laboratory, has been identified as having strong commercial potential as a significant enhancement to existing products in the machine tool industry for machine tool calibration.

Benefits

The likelihood of commercialization of an improved MDFM is high due to industrial machine tool partnerships and expertise maintained by American Research Corporation of Virginia (ARCOVA) as well as a laser-aligned robotic machine tool application currently being prototyped at ARCOVA. Significant opportunities exist in any industry that uses metal-cutting, forming or shaping machinery or coordinate measurement machines. Widespread use of the device could significantly improve the domestic capability to produce high-precision metal components utilizing older machine tools. Commercial opportunities made possible by the MDFM include low-cost machine tool calibration services, measurement tools for the rebuilding and remanufacturing of older machine tools, retrofit packages which increase the precision of existing machinery, and with enhancements to the existing design, a performance enhancement retrofit for coordinate measuring machines (CMMs).

Resources

Project Engineer: **David See**
WL/MTPM
(937) 255-3612

Contractor: American Research Corporation of Virginia

JDL Subpanel: Metals

SBIR Funded

Status

Complete
Start date: July 1995
End date: June 1996

Advanced Tooling Manufacture for Composite Structures

Contract Number: F33615-95-C-5553 ALOG Number: 1444
Technical Report Number: WL-TR-96-8017

Statement of Need

The ATMCS system, developed under U.S. Air Force Manufacturing Technology Directorate contract F33615-89-C-5715, is an expert system that automates and greatly reduces the time required to design the tooling required to manufacture composite structures. The results show a 95 percent reduction in time, and the potential for cost savings using this system are enormous for the aircraft industry. The development work resulted in an implemented system at Northrop Aircraft, the prime contractor, and at several beta sites within the composites supplier sub-tier.

Tool design and fabrication are the crucial steps in manufacturing of sheet metal parts. During the process of metal forming, the blank conforms itself to the configuration of the tool. Therefore, a faulty tool will produce an unacceptable part. At present, the remedy for this problem is the check/straightening or handworking of the part following the forming operation. This manual rework sometimes accounts for 40 percent of the total touch labor hour in aerospace industries. In addition, handworking inevitably leads to the variability of the part which results in additional cost during subassembly or final assembly of the product. The majority of the metal fabricators still use the trial-and-error approach to produce tools. It is not uncommon to rework a tool for a complex forming operation like stretch forming, five times. This system would resolve the problem of cost, quality, production cycle time, and time for prototyping.

Approach

An in-depth analysis was conducted of the application of ATMCS to metal forming. The contractor developed requirements and evaluated how well ATMCS could meet those requirements. It was concluded that ATMCS can be utilized to design metal forming tools. Alternative ways were also identified to implement the system, which would improve the existing ATMCS configuration. Technical activity is complete. The final report (Advanced Tooling Manufacture for Composite Structures (ATMCS), March 1996, WL-TR-96-8017) was submitted June 3, 1996. The contractor demonstrated the fact that the ATMCS can be used as the basis for development of a tool design software for metal forming. They also documented potential improvements to the ATMCS hardware/software environment. In addition, the results of the market research indicate that there is a tremendous demand for the software.

Status

Complete
Start date: September 1995
End date: April 1996

Benefits

The results of this program established that the ATMCS system can be applied to metal forming tooling design and that improvements can be made to the ATMCS hardware/software environments which would make it easier to use, affordable to implement, and usable by a broader base of users. The potential implementation of the system would extend the application of the ATMCS to the sheet metal fabrication process with the following benefits: a) producing accurate tooling which eliminates trial-and-error in tool fabrication, b) producing the parts with minimum cost by elimination of handworking, c) producing the parts without any variability, d) using a uniform tool design concept, and e) minimizing the process time.

Resources

Project Engineer: **Marvin Gale**
WL/MTX
(937) 255-7362

Contractor: FEM Engineering

JDL Subpanel: Metals

SBIR Funded

Metal Forming Tool Design

Contract Number: F33615-96-C-5107 ALOG Number: 1460

Statement of Need

Tool design and tool fabrication are crucial steps in the manufacture of sheet metal parts. During the process of metal forming, the blank conforms to the configuration of the tool. Therefore, a faulty tool will produce an unacceptable part. At present, the remedy for this problem is the check/straightening or handworking of the part following the forming operation. This manual rework sometimes accounts for 40 percent of the total touch labor hours in aerospace industries. In addition, handworking inevitably leads to variability of the part which results in additional cost during sub-assembly or final assembly of the product. The majority of the metal fabricators still use the trial-and-error approach to produce tools. It is not uncommon to rework a tool five times for a complex forming operation like stretch forming. The challenge of this program is to resolve the problem of cost, quality, production cycle time, and prototyping time.

Approach

This Small Business Innovation Research (SBIR) Phase II project is sponsored by the Director Defense Research & Engineering to transfer DoD developed technology into the private sector. The project is transferring technology from the Advanced Tooling Manufacture for Composite Structures (ATMCS) program into the metal forming domain. The objective is to design and implement an intuitive, easy to use, expandable, full function, brake forming, stretch forming, and hydroforming tool design software based on the original Manufacturing Technology Directorate ATMCS technology.

Benefits

There is tremendous commercial potential for the proposed metal forming tool design software. The system would:

- produce accurate tooling which eliminates trial-and-error in tool fabrication
- produce affordable parts by elimination of handworking
- produce parts with minimum variability
- use a uniform tool design concept
- minimize process time

Status

Active
Start Date: June 1996
End Date: June 1998

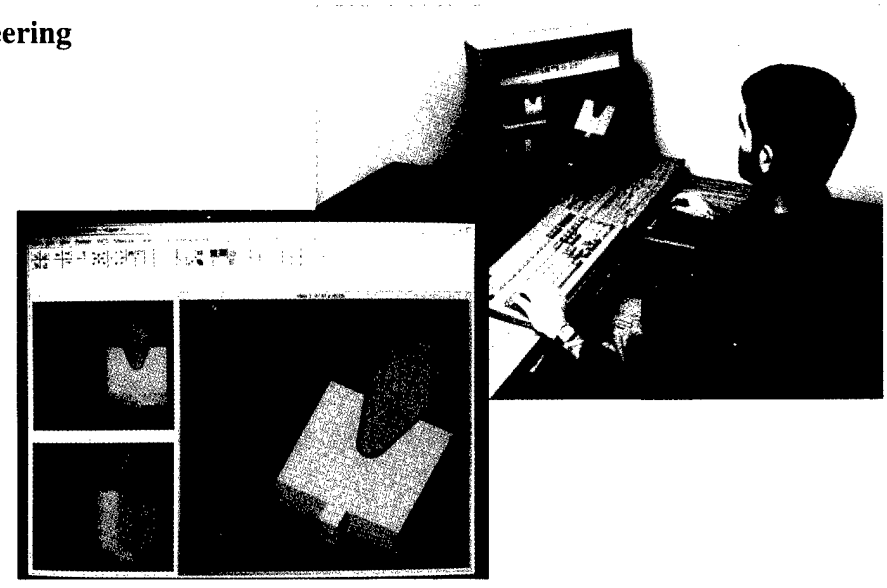
Resources

Project Engineer: **Marvin Gale**
WL/MTX
(937) 255-7362

Contractor: FEM Engineering

JDL Subpanel: Metals

SBIR Funded



Completed Projects

Composite Overwrapped Pressure Vessels

(Page 91) Contract Number: F33615-93-C-5308 ALOG Number: 609
Techical Report Number: WL-TR-96-8007

This program established the influence of variability in key manufacturing parameters on composite overwrapped pressure vessel (COPV) performance, reliability, and safety for space systems applications. The program was completed in February 1996. **JDL Subpanel:** Composites

POC: Vincent Johnson
WL/MTPN
(937) 255-7277

Composite Manufacturing Process Control System

Contract Number: F33615-95-C-5531 ALOG Number: 1409
Technical Report Number: WL-TR-96-8002

Under a Phase I Small Business Innovation Research (SBIR) contract with Assembly Guidance Systems, an integrated vision and laser projection system was developed to automatically deliver dimensional information directly from computer assisted design (CAD) data to provide in-process monitoring and documentation of correct sequence, location and orientation of the plies of composite material. The proof-of-concept system was developed at Assembly Guidance Systems, and then installed and operated in a production environment on an F-22 heavy gauge spar preform tool. The system successfully demonstrated the ability to receive CAD data; dimensionally reference on tooling; display sequence, location, and orientation of plies; and automatically verify indicators of correct sequence, location, and orientation of plies. The Composite Manufacturing Process Control System (CMPCS) will reduce development and production costs of composite structures through reduction or elimination of tooling templates, process and inspection steps, production errors and scrap. By eliminating the need for template creation, storage, operation, maintenance and modifications (and all associated labor) a direct cost savings of $3,500 to $8,000 per month will be realized for a moderately complex hand-laid up part being produced on a full time basis. The developed system also provides in-process quality control of the lay-up process, thereby eliminating the need for quality inspections. Technical activity was completed in September 1995. A Phase II effort to this Small Business Innovation Research project began in February 1996. **JDL Subpanel:** Composites

POC: Diana Carlin
WL/MTPN
(937) 255-7277

A Gap and Tape/Tow Width Sensor for On-Line Quality Control of Automated Composite Lamination Processes

Contract Number: F33615-95-C-5532 ALOG Number: 1416
Technical Report Number: WL-TR-95-8039

Technical activity is complete. The final report (A Gap and Tape/Tow Width Sensor for On-Line Quality Control of Automated Composite Lamination Processes, WL-TR-95-8039, October 1995) has been submitted. This Phase I SBIR effort involved construction of a prototype gap sensor, laboratory testing under simulated conditions, and field testing of an automatic fiber placement machine. This project was completed in October 1995. **JDL Subpanel**: Composites

POC: Vincent Johnson
WL/MTPN
(937) 255-7277

Completed Projects

Low Cost Advanced Composite Structures

Contract Number: F33615-95-C-5549 ALOG Number: 1417
Technical Report Number: WL-TR-95-8038

Technical activity is complete. The final report (Low Cost Advanced Composite Structures, WL-TR-95-8038, November 1995) has been submitted. Aspen Systems has successfully demonstrated a new class of thermoset resins during their Phase I SBIR. These materials have tremendous potential to fulfill the challenge of reducing costs in high service temperature composites. These new materials are based on orderable, low molecular weight, mesophasic liquid crystalline structures with flexible, difunctional end chains. The resulting ultracomposite is self-reinforced and toughened at the molecular level. Using "rational chemical design" principles these Liquid Crystal Thermosets have been engineered with a Low Cure Temperature, hence as a class these materials are now referred to as LCT2s. This new class represents the leading edge in thermoset monomer design and the maximum opportunity for significant cost reductions in aerospace quality, advanced composite fabrication. This project was completed in November 1995 and awarded a Phase II in April 1996, under the title, "Novel Low Cost Thermosets for Advanced Aerospace Composites." **JDL Subpanel**: Composites

POC: Vincent Johnson
WL/MTPN
(937) 255-7277

Room Temperature Cure Hydrocarbon Matrix Resin for Low Cost Resin Transfer Molding (RTM) & Filament Winding (FW) Composite Structures

Contract Number: F33615-95-C-5530 ALOG Number: 1385
Techical Report Number: WL-TR-95-8034

Technical activity was completed in November 1995. The primary goal of this Phase I SBIR program was to develop an economical composite matrix resin that is resin transfer molding (RTM) processible, cures at near room temperature and outperforms current aerospace epoxy resins. Foster-Miller achieved some of the goals by reducing the cure temperature of a low-cost, RTM processible hydrocarbon resin system from 160°C/24 hour to 60°C/4 to 6 hour or room temperature/3 days through the use of peroxide initiators and promoter. The low temperature cure characteristics of 27 resin formulations were investigated and six were selected for processing into neat resin casting. Resins exhibited densities of 0.95 g/cc, glass transition temperatures of 130°C for 7 hours, removed from the mold, and post-cured freestanding to 175°C using a conventional oven. Refinement of the RTC/RTM resin formulations and processing conditions will result in composites initially processed at near ambient temperature. Difficulties remain in trying to achieve aerospace grade properties similar to those manufactured using 3Ms PR500 epoxy resin. **JDL Subpanel:** Composites

POC: Ken Ronald
WL/MTPN
(937) 255-7278

Nonmetals

Active Projects

Bonded Wing Initiative

(Page 92) Contract Number: F33615-91-C-5729 ALOG Number: 155

Technical activity with Manufacturing Technology DIrectorate funding is complete. Bell Helicopter Textron has demonstrated new material, design manufacturing concepts identified as a key to achieving a 50 percent reduction in the manufactured cost of the V-22 composite wing. The Bell concept established and implemented a new material form, the pultruded carbon rod, within a new design concept for wing stiffeners. Cost effective use of this rod was enabled through the development of the new manufacturing equipment. Bell investigated all bonded construction, involving the bonding of thermoset to thermoplastic structures. Using a concurrent engineering format, Bell developed a highly integrated wing structure to reduce assembly cost. Fabrication costs were reduced by selecting the most cost effective match of manufacturing processes to structural requirements. Fabrication methods under this effort included resin transfer molding of stitched preforms and automated tape layup. **JDL Subpanel:** Composites

POC: Vincent Johnson
WL/MTPN
(937) 255-7277

Engines Initiative

(Page 92) Contract Number: F33615-91-C-5719 ALOG Number: 173

Update - A preform on a modified flanged mandrel was successfully braided, bagged and autoclave cured. Flange testing was performed on coupons machined from the duct. A&P fabricated the flanged preform. Six of the thick flange specimens and thin titanium load spreaders had been tested. Thinner flanges with thicker titanium and composite load spreaders were tested. A large panel was fabricated. Significant progress occurred in the development of the computer-based model for composite ducts. The overall strategy and interaction between the previous IPD tools and the cost model were established. A preliminary detail design drawing of this flange was made for the Phase II duct. **JDL Subpanel:** Composites

POC: Mike Waddell
WL/MTPN
(937) 255-7277

Wings Initiative

(Page 93) Contract Number: F33615-91-C-5720 ALOG Number: 320

Update - Significant progress was made on all risk reduction activities. Element Build-to-Package has been completed and submitted in draft form for Air Force review. All drawings for the subwings have been completed. Manufacturing plans are in progress. **JDL Subpanel:** Composites

POC: Ken Ronald
WL/MTPN
(937) 255-7278

Active Projects

Fuselage Initiative

(Page 93) Contract Number: F33615-91-C-5716 ALOG Number: 171

Update - Phase II task priorities are being reassessed to accommodate the hardware fabrication requirements of the Manufacturing/Affordability Demonstrator. The budget and schedule review currently underway indicates that in addition to requiring additional funds, the program may be completed approximately one month late. The bulkhead activity is focusing on fabrication of the bulkhead components required for the Manufacturing/Affordability Demonstration Component. Tooling for the bulkhead component is approximately 50 percent complete. Fabrication of the tooling required for the Longerons for the Task 2.12 article is underway with delivery of the longeron elements scheduled for the end of September, as required. The room temperature testing for the Effects of Holes and the Rod Termination tasks is complete. The remainder of the testing and data analysis was scheduled to be complete by the end of August, but has been delayed due to emphasis on the longeron components for the Task 2.12 demonstrator. The tow placed module task is on schedule. The first module has been completed and work is starting on the second. The design of the tooling required for the bonded assembly and tow placement for the Task 2.12 Manufacturing/Affordability Demonstration Article is complete and the tooling fabrication started. **JDL Subpanel:** Composites

POC: Dan Brewer
WL/MTPN
(937) 255-7278

Manufacturing Technology for Multifunctional Radomes

(Page 95) Contract Number: F33615-93-C-4312 ALOG Number: 655

Update - Phase I completed. Phase II underway. LADC has established a manufacturing and assembly approach which reduces part count, reduces the number of assembly cure cycles, improves the assembly tolerance variability, reduces the assembly span time, and reduces the acquisition cost by 30 percent. Preliminary tests indicate that all these goals can be met while meeting or exceeding electrical and structural performance requirements **JDL Subpanel:** Composites

POC: Diana Carlin
WL/MTPN
(937) 255-7277

Oxidation Resistant Coating Application

(Page 96) Contract Number: F33615-93-C-5309 ALOG Number: 711

Update - Coating material definition optimized, manufacturing production yield increased to 50 percent yield. Electromagnetic waveguide tests show good performance. Problems with application and adherence are requiring continued work in this area. Phase III scale-up efforts are on hold until coating system adherence issues are resolved. **JDL Subpanel:** Composites

POC: Ken Ronald
WL/MTPN
(937) 255-7278

Rapid Manufacture of Thermoplastic Radomes

(Page 97) Contract Number: F33600-90-G-5308 ALOG Number: 307

Update - This program developed a flight-capable prototype radome constructed of thermoplastic composite materials resistant to the chronic problems found in thermoset composite radomes. The program will be completed in September 1997. **JDL Subpanel:** Composites

POC: Mike Waddell
WL/MTPN
(937) 255-7277

Fiber Placement Benchmark & Technology Roadmap

Cooperative Agreement Number: F33615-95-2-5563 ALOG Number: 1470

Statement of Need

Affordability is the key challenge facing today's aerospace industry. While the weight savings benefits of composite structures has been well documented, part cost remains a major challenge. Fiber placement offers the potential to significantly reduce material waste and labor costs in comparison to conventional part fabrication methods. In addition, fiber placement provides a unique opportunity to optimize structural efficiency and to fabricate large, complex parts not feasible for fabrication by conventional methods; however, the capabilities of fiber placement are not fully understood and the complete benefits of fiber placement cannot be fully realized. The objective of the Fiber Placement Benchmark and Technology Roadmap program is to benchmark the current state-of-the-art in production fiber placement capabilities and to provide a technology roadmap for composites automation technology into the next century.

Approach

The benchmarking effort will be documented in a series of fiber placement manuals which will provide cost and capability data to optimize designs for the fiber placement process. In addition, the guidelines will provide processing data required for repeatable, high quality manufacturing.

Status

Active
Start date: November 1995
End date: August 1997

Benefits

If successful, this effort will reduce material waste and labor costs and optimize structural efficiency. It will provide guidelines to the design community and a roadmap for the machine tool builders around fiber placement technology.

Resources

Project Engineer: **Dan Brewer**
WL/MTPN
(937) 255-7278

Contractor: McDonnell Douglas Aerospace

JDL Subpanel: Composites

DARPA Funded

Novel Low Cost Thermosets for Advanced Aerospace Composites

Contract Number: F33615-96-C-5628 ALOG Number: 1455

Statement of Need

Decreasing defense budgets along with increasing commercial requirements necessitate the development of low cost organic matrix composites. Affordability includes all steps of the manufacturing process from starting materials to final inspections. New or modified materials must be able to produce aerospace quality components and at a minimal cost independent production quantity. The process starts with the resin matrix. Subsequent manufacturing operations, including tooling and autoclave requirements, are dictated by the resin chemistry. Current resin systems can only achieve high temperature performance goals through elevated autoclave cure cycling, translating to added costs throughout the manufacturing process, and reduced composite damage tolerance. Eliminating the need to process in autoclave environments will have a direct impact on cost reduction. The need exists for the development of resin chemistry which will be amenable to room temperature curing of graphite reinforced composite structures, but which subsequently possesses the same characteristics as today's state-of-the art 3500 epoxy systems.

Approach

This Phase II Small Business Innovation Research (SBIR) project will significantly reduce the costs in advanced aerospace composite fabrication. This objective will be met by using rational chemical design principles to engineer novel low temperature cure liquid crystal thermosets and by eliminating high temperature autoclave cure cycling. Designed from the molecular level, Aspen's new liquid crystal thermoset system represents a maximum opportunity for significant cost reductions in advanced aerospace composite fabrication, meeting the challenge of high temperature performance with reduced processing costs and increased damage tolerance. The novel liquid crystal thermoset class initiates a close functional group packing density, allowing complete crosslink conversion at much lower temperatures than the polymer's final glass transition temperature. The result is a high temperature, high strength polymer cured at or near room temperature with enhanced damage tolerance.

Benefits

Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed will be applicable and beneficial to industries ranging from aerospace and automotive to medical and sporting goods and concerns.

Resources

Project Engineer: **Vincent Johnson**
WL/MTPN
(937) 255-7277

Contractor: Aspen Systems Incorporated

JDL Subpanel: Composites

SBIR Funded

Status

Active
Start date: April 1996
End date: February 1998

Dynamic Polymer Composite (DPC) Connectors for Affordable Composite Structures

Contract Number: F33615-96-C-5622 ALOG Number: 1445
Technical Report Number: In progress

Statement of Need

Decreasing defense budgets along with increasing commercial requirements necessitates the development of low cost organic matrix composite structures. A large percentage of the costs are associated with assembly and repair of composite structures. Currently, there are no available joining methods that lend themselves to quick and easy field assembly and repair of aircraft composites. Joining concepts are required that: 1) may be used under field conditions with a minimum of tools/equipment, 2) develop an adequate portion of the strength of the structural members themselves, 3) minimize or eliminate surface preparation, and 4) minimize the need for precise dimensional tolerances.

Approach

This program will characterize DPC connectors. The process will begin with a survey of material and a computer simulation. These tasks are to establish basic parameters for design and determine the limits of clamping force that can be held by the DPC connection. The next three sections involve putting the science to work. This will be achieved through design, fabrication, and demonstration.

Status

Complete
Start date: April 1996
End date: November 1996

Benefits

Dynamic polymer composite connectors will enhance the future of composite aircraft. Not only do they create a smooth stress flow between cylindrical structural members, but they also allow for composite airframes to be component assembled, and give greater flexibility with airframe design improvements.

Resources

Project Engineer: **Vincent Johnson**
WL/MTPN
(937) 255-7277

Contractor: The Technology Partnership

JDL Subpanel: Composites

SBIR Funded

High Temperature Bagging/Sealant Materials for Composite Manufacturing

Contract Number: F33615-96-C-5626 ALOG Number: 1457

Statement of Need

As temperature requirements continue to increase on Department of Defense weapons systems, new materials have been developed which offer increased structural performance at elevated operational temperatures. However, these matrix systems are typically processed at temperatures greater than 600° Fahrenheit and pressures of 200 psi and tend to degrade current ancillary processing materials such as bagging materials and sealants. This may cause failure of the bagging material or sealants during processing and may lead to poor part quality and increased costs. Also, as composite components become larger and more complex, bagging materials must be available in sufficiently large sizes to eliminate the need for seaming which can also lead to bag failures. The tooling required for larger parts also requires longer heat up times which further increases the time the processing materials are exposed to elevated temperatures. In order to efficiently utilize organic matrix resins, which process at elevated temperatures, production hardened ancillary processing materials must be available.

Approach

The main approach will be to formulate a high temperature resin system that can be processed. This will be done by investigating improvements of silicone rubber fluoropolymers, polymides, fluro or polyethers, or polysultones polymers.

Status

Active
Start date: April 1996
End date: January 1997

Benefits

Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

Resources

Project Engineer: **Vincent Johnson**
WL/MTPN
(937) 255-7277

Contractor: Utility Development Center

JDL Subpanel: Composites

SBIR Funded

Composite Manufacturing Process Control System

Contract Number: F33615-96-C-5627 ALOG Number: 1415

Statement of Need

Process controls are one of the key elements of building quality into an organic matrix advanced composite structure. Built-in quality reduces inspection, rework and scrap costs, increases reliability and results in lower overall acquisition costs. The majority of process controls investigated to date have focused on the curing process.

A recent study has shown that human error during the lay-up of composite parts such as mislocated plies, mistrimming, and placement of incorrect material can account for 36 percent of non-conforming parts in production. Rework and scrap are generally attributed to incorrect location and orientation of plies, foreign objects, and missing plies.

Almost all hand-laid composite parts created today are produced using templates to show the assembler where to place each component in the laminate. Templates are hard tooling and are the full size and shape of the part to be produced. One study has shown that the time required to handle the template is equal to the time required to place the actual composite material. Using templates to inspect for proper ply location and orientation is an expensive and cumbersome process. The template handling and deciphering time exceeds the time required for actual inspection.

Approach

The proof-of-concept system was demonstrated in Phase I of this effort. Phase II brings together a team comprised of Assembly Guidance Systems, Inc., Bell Helicopter Textron, Inc. and Hexcel Structures to implement and refine the CMPCS system. The CMPCS provides accurate laser patterns showing placement locations for composite material and core. Non-value-adding costs of template fabrication, storage, retrieval, registration, deciphering, scribing, reworking, and training are eliminated with the CMPCS. The CMPCS operates with CDRH Class II laser safety, is portable and can be set up by one person in less than 15 minutes. The CMPCS provides automatic, in-process verification and documentation of each ply of composite material as it is being laid up. The CMPCS can function as a complete stand alone system or be integrated with other systems such as filament winders, automatic compaction systems or tape layers. Initial applications of the CMPCS will begin in late 1996 on C-17 wing to body fairings and CV-22 rotor blades.

Status

New start
Start date: May 1996
End date: May 1998

Benefits

Benefits from this effort include reduced acquisition costs and overhead costs for composite parts.

Resources

Project Engineer: **Diana Carlin**
WL/MTPN
(937) 255-7277

Contractor: Assembly Guidance Systems

JDL Subpanel: Composites

SBIR Funded

Enhanced Pultruded Composite Materials

Contract Number: F33615-96-C-5629 ALOG Number: 1467

Statement of Need

This Historically Black Colleges and Universities (HBCU) program looks at pultrusion manufacturing technology. Most pultrusion research studies to date, including that of the previous Phase I Wright Laboratory sponsored research (Aerospace Sciences Research and Development, F33615-91-C-5727), have examined simple pultruded shapes (e.g., simple flat or circular geometries), and have related processing conditions of these shapes to the expected mechanical properties of the composite. However, most design applications require products in more complex shapes, and unfortunately for composite materials, knowledge of composite material properties for simple shapes does not imply knowledge of the mechanical properties for the more complex shapes. Complex shaped composites need to be carefully designed for proper fiber placement and alignment, in addition to all those factors that normally affect pultruded composites.

Approach

A major expansion of the previous research will be to manufacture (pultrude) composite materials in optimized engineering design geometries such as I-beams, T-beams, L-beams, or hollow tubes. The use of composite materials in wide ranging design applications will make the study of structural geometries necessary. The manufacture of these shapes will require the use of fiber fabric. In the past research (Phase I) only unidirectional (longitudinal oriented) fibers were employed. The use of fabric will provide an opportunity to vary the mechanical properties as a function of fiber orientation (direction). The research will also use "hybrid" glass/graphite fiber. After manufacturing these shapes for a variety of operational pultrusion parameters (pull speed, fiber volume lay-up and hybridization, and die temperature profile), the composite materials will be tested to determine the mechanical/physical properties.

Status

Active
Start date: May 1996
End date: April 1998

Benefits

This research will develop a basic understanding of the manufacture of complex pultruded shapes. This understanding will tie the properties of useful structural shapes to those pultrusion process conditions used to produce them. In addition, the structural shapes produced will be studied to provide the most desirable composite material properties by taking advantage of the best combination of properties from both graphite and glass fiber. By using this hybrid composite, using the best of both graphite and glass, the pultrusion process can be optimized to produce useful structural shapes.

Resources

Project Engineer: **Vincent Johnson**
WL/MTPN
(937) 255-7277

Contractor: Rust College

JDL Subpanel: Composites

Completed Projects

Chemical Tank Rejuvenation

(Page 99) F33615-93-C-5304 ALOG Number: 616
Technical Report: In progress
This program established the feasibility for a chemical rejuvenation system to reverse the contamination and remove sludge from nitric acid stripping solutions, without removing the tanks from service. The effort also developed an in-situ, non-rejuvenating system to reduce the sludge formation in sodium hydroxide process solutions. The program was completed in November 1996. **JDL Subpanel:** Metals

POC: Rafael Reed
WL/MTPM
(937) 255-2413

Plating Bath Rejuvenation

(Page 105) Contract Number: F33601-94-D-J018 ALOG Number: 1198
Technical Report: In progress
Activities performed during last reporting period include organizing consortium members, and starting work on Phase I. Completion date was October 1996. **JDL Subpanel**: Metals

POC: Deborah Kennedy
WL/MTPM
(937) 255-3612

Repair Technology for Printed Wiring Assemblies

(Page 106) Contract Number: F33615-91-C-5700 ALOG Number: 100
Technical Report: In progress
A modular automated system which repairs high density electronic assemblies has been installed at WR-ALC. This project was completed in January 1996. **JDL Subpanel:** Electronics

POC: Troy Strouth
WL/MTMM
(937) 255-2461

Active Projects

Flexible Automated Welding for Single Crystal and Directionally Solidified Blade Tip Repair

(Page 100) Contract Number: F33615-93-C-4301 ALOG Number: 314

Update - Effort on development of the WITNESS model and B. SMART user interface intensified. BRP team personnel spent time at OC-ALC developing a general understanding of the repair activities and characterizing the HPT blade repair processes. Efforts were also focused on gathering operations and financial information needed for estimating the cost of repairing HPT blades using existing equipment and current repair processes and procedures. Numerous methodological issues were resolved regarding how best to structure the benefits analysis to effectively use data developed for the WITNESS model, and how to employ WITNESS modeling results for estimating costs. **JDL Subpanel:** Metals

POC: David See
WL/MTPM
(937) 255-3612

Active Projects

Large Aircraft Robotic Paint Stripping

(Page 101) Contract Number: F33615-91-C-5708 ALOG Number: 165

Update - The Navy Waterjet Stripping System was operated in production at Puget Sound, stripping 80,000 square feet of the U.S.S. Abraham Lincoln, Aircraft Carrier. The LARPS robot hardware is currently fabricated, integrated and has successfully completed minimum Phase II validation test requirements at the contractor's facility, and the installation facility tests at OC-ALC. To date, fully automated production, coordinated, simultaneous nine-axis movement of the robot system has been demonstrated. Phase II validation testing of the system was completed in May 1996, and the LARPS robot hardware is currently being installed in Building 3105, Tinker AFB, OK. The Phase III verification (first production stripping) test for the C/KC-135 is scheduled for January 1997, with the B-1B scheduled to be completed by March 1997. **JDL Subpanel**: Metals

POC: David See
WL/MTPM
(937) 255-3612

Laser Cleaning and Coatings Removal

(Page 102) Contract Number: F33615-95-C-5515 ALOG Number: 1230

Update - Stop work removed in November 1995. Kick-off meeting held March 12-13, 1996, in Albuquerque, NM. **JDL Subpanel:** Composites

POC: Mike Waddell
WL/MTPN
(937) 255-7277

Manufacturing of Thermoplastic Composite Preferred Spares

(Page 103) Contract Number: F33615-91-C-5717 ALOG Number: 172

Update - Activities have focused on building and testing the IPMS, and on completion of part selection activities at E-Systems and OC-ALC. A program review was held at E-Systems' Greenville, Texas facility at which program issues and progress were reviewed, and a part was selected for demonstration at OC-ALC. The IPMS has been installed at Warner-Robins ALC. **JDL Subpanel:** Composites

POC: Diana Carlin
WL/MTPN
(937) 255-7277

Metal Forming Simulation

(Page 104) Contract Number: F33615-93-C-5318 ALOG Number: 615

Update - Activities have been focused on development of the Analytical and Material Models. Phase II consists of three tasks. In addition to these tasks, Reverse Engineering has been added to the Phase II tasks. During the Reverse Engineering task, existing parts will be digitized and CAD drawings will be generated. Completion date is September 1997. **JDL Subpanel**: Metals

POC: Deborah Kennedy
WL/MTPM
(937) 255-3612

Spare Part Production and Reprocurement Support System

(Page 107) Contract Number: F33615-90-C-5002 ALOG Number: 101

Update - Major portions of the system are complete and are undergoing production test in the areas of Engineering Data Screening, Component Reverse Engineering, Manufacturing Cell for Aircraft Bushings, and Hazardous Material Procurement Tracking. The single theme between these diverse areas is the concept of workflow management and movement of engineering data via the local network. **JDL Subpanel**: Manufacturing and Engineering Systems

POC: John Barnes
WL/MTIM
(937) 255-7371

Active Projects

Agile Web

(Page 108) Cooperative Agreement Number: F33615-94-2-4412 ALOG Number: 1211

Update - A program review was held to review the results of the project to date. Agile Web staff attended the Fifth National Agility conference, in Boston. Projects focusing on the Quality System, the Virtual Organization Agreement (VOA) and the Web communication system are all in progress. The Agile Web has announced the appointment of Bill Adams as the new president of Agile Web, Inc. The main focus of Agile Web is to generate self sufficiency by December 1996.

POC: George Orzel
WL/MTII
(937) 255-7371

CommerceNet

(Page 109) Cooperative Agreement Number: F33615-94-2-4413 ALOG Number: 1210

Update - CommerceNet has become one of the premier industry associations for developing and promoting the use of Internet Commerce. The CommerceNet consortium was originally funded as 50/50 Industry/Government cost share through the Technology Reinvestment program. The CommerceNet consortium has now grown to over 150 organizations including several Fortune 500 organizations. They include the leading banks, telecommunications companies, VANs, ISPs, online services, and software and services companies, as well as major end-users, who together are transforming the net into a global electronic marketplace. CommerceNet, realizing the advanced global market that is available over the Internet, has also established affiliate organizations in Japan and Canada. In the fall of 1996, CommerceNet held its first major conference and Global Partner Summit. CommerceNet continues to validate the use of electronic commerce through industry pilots, white papers on critical Internet issues, and validation of crucial Internet technology components. CommerceNet and Neilsen Research also conducted a two-phase survey of Internet usage in the United States during the last year.

POC: Brian Stucke
WL/MTII
(937) 255-7371

Improving Manufacturing Processes in Small Manufacturing Enterprises

(Page 110) Cooperative Agreement Number: F33615-94-2-4418 ALOG Number: 1212

Update - The Higher Education Manufacturing Process Applications Consortium (HEMPAC) has requested a 12-month, no-cost time extension to enhance this project by adding a supply chain aspect to the Manufacturing Improvement Process (MIP). This supply chain aspect will extend the MIP approach to address reduction of the time needed to introduce innovation across a supply chain. This supply chain project will include an OEM, supplier and sub-tier supplier. We are currently processing this request. This request also includes reducing the number of MIP projects implemented from 36 to 29.

POC: Cliff Stogdill
WL/MTII
(937) 255-8589

Active Projects

Kansas Manufacturers, Inc. (formerly, Kansas Manufacturers Association)

(Page 111) Cooperative Agreement Number: F33615-94-2-4419 ALOG Number: 1219

Update - The organizational structure has been changed from an association to a for-profit joint venture to better reflect the emphasis on product development and marketing. Dues are no longer being collected and the future of the organization is based on the ability to: identify successful products; conduct market research; contract with owner companies to manufacture the products; develop successful sales and distribution strategies; generate a profit from operations. The first two products developed under the stage gate system were an alignment system and a "Hickey Picker" for the printing industry. The Precision+ automotive alignment system enables any shop to perform complete four-wheel alignments on today's modern vehicles without dedicated bays, expensive computers, or turntables and slip plates. Precision+ combines affordability with ease of use, accuracy and reliability. In fact, the investment is so low that with just two alignments per week this product will pay for itself in less than a year. This product, which has been used in the Wichita area, will be introduced to the national and international market at the Automotive Aftermarket Industry Week trade show in Las Vegas in November. The Hickey Picker is an automated system that removes dirt and impurities from printing plates while the press is in operation. It improves efficiency and safety. Initial sales have been strong and the order backlog extends through October. Although product development and marketing have been the primary focus in 1996, the other TRP programs in the areas of strategic planning, management training, employee training, and electronic commerce have been moving smoothly to completion. The last new program to be considered will focus on employee hiring and retention, a current problem in the tight labor market.

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Minnesota Consortium for Defense Conversion

(Page 112) Cooperative Agreement Number: F33615-94-2-4417 ALOG Number: 1220

Update - The Minnesota Consortium for Defense Conversion (MCDC) currently has 65 members and has cost-shared 63 projects aimed at new product development, joint production, process improvement and/or augmenting sales. In addition to these individual one-on-one cost share projects, the Consortium has developed a number of "one to many" programs aimed at combining group educational opportunities with one-on-one implementation assistance. These programs include: 1) Electronic Data Interchange with the Cleveland Electronic Commerce Resource Center and Minnesota Project Innovation as partners; 2) "From Workshop to Workplace," a process improvement series linked to the University of Minnesota and the Center for the Development of Technological Leadership; 3) a Sales and Tradeshow Training series; 4) a "Best Management Practices" series in cooperation with the University of St. Thomas; and 5) a series on "Inter-firm Collaboration" with US Net as a partner.

POC: Cliff Stogdill
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New England Supplier Institute

(Page 113) Cooperative Agreement Number: F33615-94-2-4424 ALOG Number: 1228

Update - Several workshops were held. NESI worked with Markem Corporation to develop and deliver their first Supplier Day event with a group of key suppliers. Extensive work was done to improve and broaden NESI's partnerships with other service providers and industry organizations in the state.

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Oregon International Internship Program

Cooperative Agreement Number: F33615-95-2-5552 ALOG Number: 1466
Technical Report Number: In progress

Statement of Need

In looking to the future, it is clear that more effort needs to be given to peace-making and peace-keeping initiatives including training that contributes to economic competitiveness and an improved understanding of the methods, processes and procedures in other countries that are relevant to changing security needs in the U.S. A key component in developing an affordable solution to meeting the demands of the 21st century is to foster the integration of international internship experiences into areas that are relevant to our future security as a nation and that have not previously been internationalized — the sciences, professional schools and technical programs. These academic areas are critical to U.S economic and scientific competitiveness, but their programs generally do not reflect the importance of the field's international dimensions. Events outside the U.S. are changing the nature of the professions and the U.S. preeminence in these areas is being challenged by overseas competitors. In fact, every undergraduate needs to have the opportunity to acquire an international dimension to their academic degree.

Approach

The Oregon State System of Higher Education (OSSHE) consists of eight institutions of higher learning located throughout the state of Oregon. Part of the OSSHE mission is to internationalize Oregon's higher education institutions. OSSHE has pursued this goal by establishing centers of excellence to address global problems. OSSHE, in cooperation with Oregon Economic Development Department (OEDD), will structure an international internship program to quickly and efficiently establish an effective network of contacts and opportunities to capitalize on the developments that are occurring in international manufacturing, engineering, management, environmental studies and other disciplines.

The OSSHE institutions currently coordinate academic exchange programs with 50 partner institutions in 16 countries. Students who complete study abroad are prime candidates for international internships. The International Internship Program will build on this existing OSSHE network of international exchange programs to identify internship placement overseas. In addition, over 50,000 OSSHE alumni are located in 129 countries, often holding significant positions in government agencies, private companies, and institutions. They provide an additional source of contacts for internships.

Status

Complete
Start date: August 1995
End date: August 1996

Benefits

The International Internship Program will provide students with internship opportunities in their field, both in domestic and international settings. Students will begin their internships with a participating Northwest business or agency for three weeks before joining a comparable organization in a host country. Following their international internships, the students will return for an additional three weeks with the cooperating Northwest organization. This design offers advantages to the students and cooperating Northwest business or institution. The students get valuable "hands-on" training and a cross-cultural perspective on their profession. The businesses benefit from the returning students' technical and cultural insights into a comparable international business, and from the contacts the student establishes while in-country. Finally, the U.S. company benefits by having an opportunity to train a potential new employee at minimal cost.

Resources

Project Engineer: **Patrick Price**
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Contractor: Oregon State University

National Excellence in Materials Joining Education & Training

Grant Number: F33615-94-1-4416 ALOG Number: 1224

Statement of Need

Maintaining a competitive edge in the global marketplace requires U.S. manufacturers to continuously improve product quality, reduce costs and respond quickly to changing markets and customer demands. Materials joining is a critical "enabling" technology that permeates the manufacturing arena, including both military systems and commercial products. In Ohio, over 500,000 workers are employed in industries dependent on materials joining and allied technologies. A major deficiency in both the Ohio and U.S. manufacturing infrastructure is the absence of an engineering workforce educated and trained in the various aspects of materials joining. As the technology becomes more sophisticated and the requirement for a highly educated and trained materials joining workforce increases to meet ISO 9000, CEN and NAFTA requirements, this deficiency will increasingly place U.S. industry at a competitive disadvantage.

Approach

The programmatic approach is structured to facilitate access to a systematically-designed and coordinated instruction base aimed at retraining the manufacturing workforce through a variety of interrelated instruments. This comprehensive education and training program will provide a ready-made, nationally-approved means for attaining industry-recognized diplomas, certificates and degrees. This instruction base will take the form of learning "modules" and will be designed to satisfy a wide range of training requirements. A four-level, module-based training package in the area of materials joining will be devised. The first level will consist of 4-8 hour, classroom-based lecture modules that are introductory in nature and cover broad areas of materials joining, e.g., Arc Processes, Beam Processes, Resistance Welding and Solid-State Processes, Materials, Design/Fitness-for-Service, Nondestructive Testing and Economics. The second level, also classroom-based, would be comprised of more detailed, specific modules under one of the broad topics listed above. At the third level, many of the specific topics would have associated, hands-on laboratory/practical modules. Finally, at the fourth level, teaching factory modules would be developed in a select number of areas which provide extensive practice-oriented design and process application experiences.

Benefits

This unique and innovative program will build upon existing programs and utilize a strong regional network of academia and industry to retrain and reorient the manufacturing workforce to meet a diversity of pertinent industry needs. Once developed, NEMJET will serve as a national model for the establishment of other programs critical to the manufacturing infrastructure.

Status

Active
Start date: March 1994
End date: March 1997

Resources

Project Engineer: **Theodore Finnessy**
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Contractor: Ohio State University

DARPA Funded

National Industrial Information Infrastructure Protocols

Cooperative Agreement Number: F33615-94-2-4447 ALOG Number: 1227

Statement of Need

The virtual enterprise is the bold, new concept of many small independent companies (or parts of large companies) joining together to work as a single enterprise on a specific project. In this way, widespread companies with their respective areas of expertise can complement one another and join forces quickly to create and manufacture superb products at very competitive prices. This synergistic process is believed by many experts to be the organizational concept the U.S. must exploit to create increased worldwide demand for a new generation of superior American products and generate millions of additional U.S. manufacturing jobs. A major inhibitor to implementing this concept is the lack of a national computer infrastructure. The NIIIP program will overcome this inhibitor. NIIIP will consolidate, rationalize, and integrate a set of standards upon which applications will be built and virtual enterprises will be formed. Jobs will be created in the computer industry and in the organizations which participate in virtual enterprises.

Approach

The National Industrial Information Infrastructure Protocols (NIIIP) Consortium is a team of organizations that has entered into a cooperative development agreement with the U.S. government to develop open industry software protocols that will make it possible for manufacturers and their suppliers to effectively interoperate as if they were part of the same enterprise, even though many of these interactions are unscheduled, occur between both sophisticated and relatively unsophisticated users who utilize a wide range of computer systems, operating environments, and business processes.

These protocols will enable a new form of collaborative computing in support of highly efficient and globally competitive "Virtual Enterprises."

Status

Active
Start date: September 1994
End date: March 1997

The first three cycles of this four-cycle development program are complete. Most internet tools are in place and advanced security measures are being developed. Many commercial products have been modified for CORBA standards compliance. The Reference Architecture for the NIIIP protocols has been instantiated in detail. The advancements for the next development cycle include the development and test of several critical software agents, the initial implementation of a knowledge base environment, and a rigorous implementation of a workflow management environment.

Benefits

The NIIIP Consortium approach converges commercial off-the-shelf standards and tools, the skills of the team members (the leading practitioners of each of the relevant technologies), to offer a powerful solution for the virtual enterprise. A summary of the benefits of this solution include:

- Enables organizations to quickly form a Virtual Enterprise on an ad hoc basis.
- Provides means for rapid reaction and reduced design cycle times.
- Overcomes inhibitors to information accessing, sharing, and communicating.
- Permits users to focus on product solutions, not computer constraints.
- Includes all sizes of companies from the smallest to the largest.
- Increases efficiency and improves quality of design and manufacturing of products, leading to increased world demand and more U.S. jobs.

Resources

Project Engineer: **John Barnes**
WL/MTIM
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Contractor: International Business Machines Corporation

DARPA Funded

Practice-Oriented Masters Engineering Program

Grant Number: F33615-94-1-4422 **ALOG Number: 1225**

Statement of Need

The National Research Council's study of research priorities for U.S. manufacturing identified manufacturing skills improvement as one of the critical needs. This report stated "What modern manufacturing needs — and is not getting — are master technicians and Renaissance engineers." The same theme in different words is heard from senior executives who complain that functional barriers within their organizations present roadblocks to developing required competitive capabilities. Organizing the business teams frequently exposes a new problem — the specialists do not have sufficient understanding of the other functions to perform effectively as a member of the business team. The current university system produces engineers with depth in fundamentals but insufficient skills for professional practice, particularly in manufacturing. Students typically receive little, if any, exposure to manufacturing.

Approach

POMEP establishes a master's program to perfect the advanced professional education component of the Partnership for Systemic Change in Manufacturing Education. POMEP is a cross-departmental, cross-college, practice-oriented certificate program. The student simultaneously receives a Masters of Science degree from an engineering department plus a certificate in manufacturing engineering. The key components are a major in a manufacturing subject area, an interdisciplinary principles of manufacturing core involving both engineering and business, plus a practicum in industry. Industry is greatly involved in both the principles of manufacturing core and the practicum. The program is adaptable to local conditions and can be deployed in any engineering graduate program with significant manufacturing activity, making it a model for nation-wide use. POMEP will be implemented at The Ohio State University and Drexel University to test its viability as a national model.

Status

Active
Start date: March 1994
End date: March 1997

Benefits

The Partnership for Systemic Change in Manufacturing Education brings together two major forces for change in engineering education — the Engineering Research Center for Net Shape Manufacturing (ERC/NSM) and the Gateway Engineering Education Coalition. The ERC program was instituted to "change the culture of engineering education and research." The engineering coalitions are charged with improving undergraduate education. Coupling this ERC, one of the very few manufacturing ERCs, with an education coalition produces a team uniquely qualified to bring about needed systemic change in manufacturing education. By expanding and integrating the programs of the ERC/NSM and Gateway, a new model will be created and have important immediate impacts on manufacturing education for the emerging global and dual-use market places.

Resources

Project Engineer: **Theodore Finnessey**
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Contractor: Ohio State University

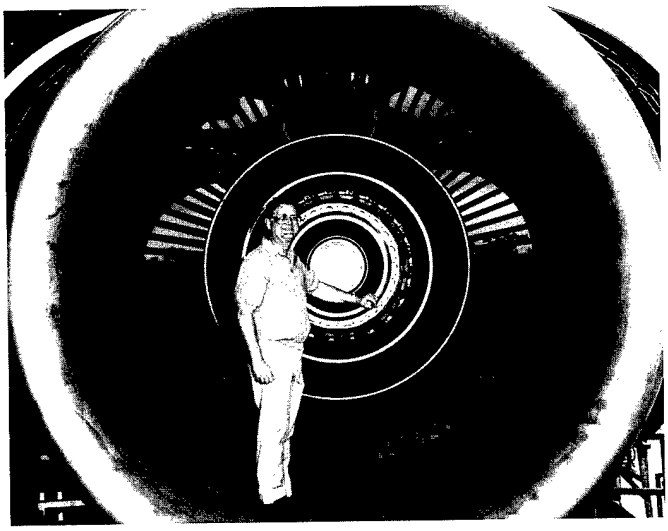
DARPA Funded

Completed Projects

Discontinuous Reinforced Aluminum

(Page 115) Contract Numbers: F33733-89-C-1011 & F33733-89-C-1015 ALOG Numbers: 1312 & 1313
Technical Report Number: In progress

The Defense Production Act (DPA) Title III Program, executed by the DPA Branch of the Manufacturing Technology Directorate, successfully completed a project with DWA Composites which enabled them to establish a viable Discontinuously Reinforced Aluminum (DRA) production capacity to support DoD and commercial applications. Financial incentives provided under the DPA allowed DWA Composites to establish a high quality material production capacity of 150,000 pounds per year, complete MIL-HDBK-5 testing, and qualify DRA in both DoD and commercial aerospace applications. With DoD and commercial applications in production, DWA is already producing material and during 1997 is expected to be producing near capacity. Insertions of DRA have significantly reduced maintenance and downtime for Air Force aircraft. Working with the F-16 office at Ogden Air Logistics Center, the PRAM office, and Lockheed-Martin, the DPA Branch provided resources to qualify DRA for use in F-16 ventral fins and access doors. By using DRA, the F-16 ventral fin mean time between failure (MTBF) has increased from 400 to 6,000 hours with no weight impact and minimal increase in part cost. The F-16 program has reported a 40:1 return on investment due to reduced inspection, maintenance and downtime. Using DRA sheet and improved fasteners, F-16 access door MTBF was increased from 2,000 to 8,000 hours. A 40 percent stress reduction in fatigue prone areas was achieved. Sustainment applications in Navy aircraft and other Air Force aircraft are currently under consideration. In addition to the DoD applications, the Pratt and Whitney (P&W) 4084 engine developed to power the Boeing 777 contains DRA. An application in production is the fan exit guide vanes for the 112-inch diameter engine. These vanes provide nacelle structural attachment to the engine as well as route the air flow from the bypass fan. DRA was chosen for this application as a more damage-resistant, lower-cost replacement for polymer matrix composite vanes. The DRA vanes are not only less expensive to produce, but will also contribute to a lower life cycle cost of the engine for the owner. The program was completed in September 1996.



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Silicon on Insulator/Silicon on Sapphire Wafers

(Page 120) Contract Number: F33733-88-C-1010 ALOG Number: 1314
Technical Report Number: In progress

This Title III program established domestic production of four-, five-, and six-inch wafers. The program was completed in December 1995.

POC: Eric Pohlenz
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Active Projects

Flat Panel Displays

(Page 116) Contract Numbers: Numerous ALOG Numbers: 1300, 1373-1378

Update - This program is being designed to facilitate the insertion of FPDs into avionics and other military-related applications. Military users will be given financial incentives to insert domestic FPDs into their systems. Incentives may be in the form of reduced costs for initial purchases for the systems, or Title III may defray the costs of qualifying the domestically produced FPD for the users' systems.

POC: John Blevins
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High Purity Float Zone Silicon

(Page 117) Contract Number: F33733-93-C-1014 ALOG Number: 1304

Update - This project seeks to establish a commercially viable production capacity through a phased development approach.

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Open Architecture Machine Tool Controllers

(Page 118) Contract Number: F33733-95-C-1088 ALOG Number: 1305

Update - This project is to establish an Open Architecture for machine tools. Machine tool builders, control builders, software houses and sensor builders are pooling their expertise to establish an "agent bases" architecture specification. The architecture specification is to be open, such that it will accommodate all customer needs; i.e., all networks, all brands of machine tools, both turning and milling types of machine tools, the addition of sensors for added process control, will use all previously written "part program" (design software) and much more. Multiple prototypes are to be built soon using this new architecture specification and tested in various types of sites. These test sites are to include at least one DoD site, combination of both large and small commercial sites, with either a turning or milling machine, or turning and milling manufacturing cells. Openness will then be validated when "upgrades" are installed by the independent test site (owner of the machine tool) staff or hired integrator (verses the original machine tool builder or control builder).

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Semi-Insulating Gallium Arsenide Wafer

(Page 119) Contract Numbers: F33733-94-C-1017, F33733-94-C-1019, F33733-94-C-1020, ALOG Numbers: 1301-1303

Update - The objective of this project is to assure a viable world-class domestic manufacturing capability to produce semi-insulating gallium arsenide (SI GaAs) substrates in support of Department of Defense (DoD) and commercial requirements.

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